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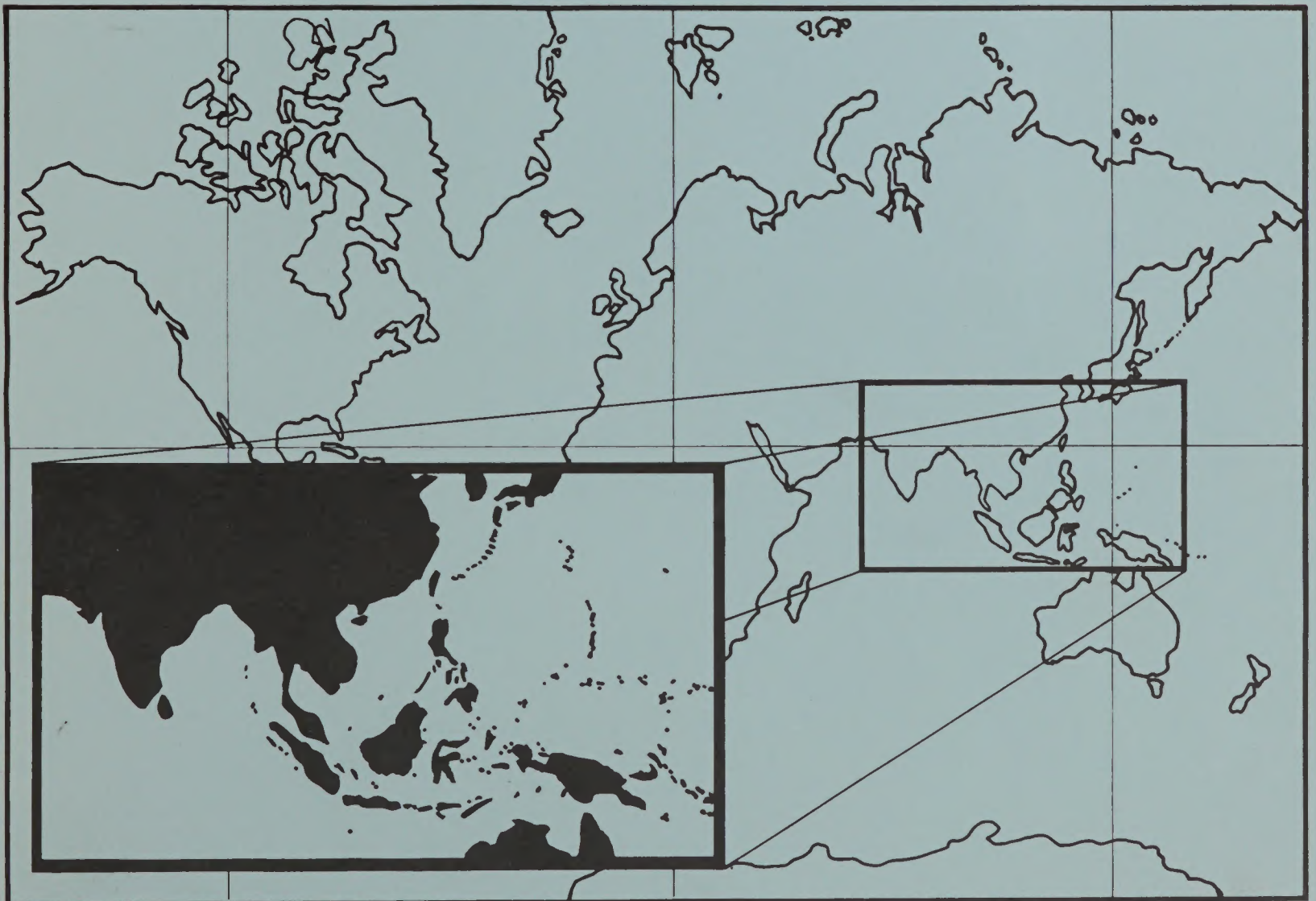
United States  
Department of  
Agriculture

Forest  
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1984

# Increasing Productivity of Multipurpose Tree Species: A Blueprint for Action

IUFRO Planning Workshop for Asia  
Kandy, Sri Lanka  
July 16-28, 1984





**United States  
Department of  
Agriculture**

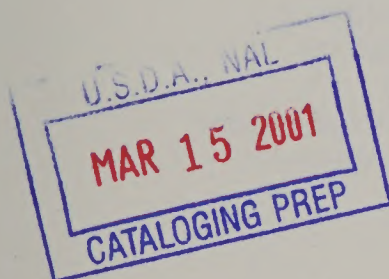


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Internationaler Verband Forstlicher Forschungsanstalten

**IUFRO Planning Workshop  
for Asia  
16-28 July 1984  
Kandy, Sri Lanka**



**Increasing Productivity  
of  
Multipurpose Tree Species:  
a  
Blueprint for Action**

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The organization of the workshop was made possible by contributions made by:

ANAB (Australian Development Assistance Bureau)  
ANU (Australian National University)  
EWC (East-West Center)  
FAO (Food and Agriculture Organization of the United Nations)  
GTZ (German Agency for Technical Cooperation)  
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UNDP (United Nations Development Program)  
UNESCO (United Nations Educational, Scientific, and Cultural Organization)  
USAID (United States International Development Cooperation Agency —  
Agency for International Development  
WB (World Bank)



The Asian Region Workshop "Increasing Productivity of Multipurpose Tree Species" was the first of its kind. It was organized by the International Union of Forestry Research Organizations (IUFRO) under the Special Program for Developing Countries as an outcome of the 1981 IUFRO Seventeenth Congress in Kyoto, Japan. Forestry leaders from the developing countries and international agencies were highly concerned about the relatively low priority being given to forestry research and the lack of emphasis on social forestry.

The new IUFRO Special Program for Developing Countries (recommended in a joint World Bank/FAO paper, "Forestry Research Needs in Developing Countries") presented at the 1981 Congress was designed to provide for research planning workshops in Asia, Africa, and Latin America. The World Bank and United Nations Development Program (UNDP) provided funding for 2 years for a Special Program Coordinator, Oscar Fugalli, formerly with FAO. Fugalli's main tasks are to organize three workshops in Asia, Africa, and Latin America on research themes of common interest to those regions and to generate funding from other donors for this Special Program.

The workshop held in Kandy, Sri Lanka, was attended by 46 people. For the first time in the history of IUFRO meetings, participants from developing countries (25) outnumbered those from developed countries (21). Twelve Asian countries were represented: Bangladesh (2); Peoples Republic of China (1); India (4); Indonesia (2); Malaysia (3); Nepal (2); Pakistan (2); Papua New Guinea (1); Philippines (2 + 1 East-West Center); Sri Lanka (2); Thailand (2); and Taiwan, ROC (1).

Fourteen of the 25 Asian participants are scientists from research institutions. Five are forestry administrators, and two are associated with university teaching. The remaining four represented national research councils, consulting firms, or the East-West Center.

Ten donors were represented: East-West Center (EWC); Food and Agriculture Organization (FAO) of the United Nations; Gesseellschaft fur Technische Zusammenarbeit (GTZ); International Council for Research in Agroforestry (ICRAF); International Development and Research Center (IDRC); Overseas Development Administration (ODA) (unofficially); Swedish International Development Agency (SIDA); United Nations Educational, Scientific, and Cultural Organization (UNESCO); U.S. Agency for International Development (USAID) and the World Bank. We are extremely grateful for donor contributions, which made the workshop possible. Special recognition must be given to the Bureau for Asia and the Bureau for Science and Technology of USAID, who together provided more than half of the workshop's budget.

Appreciation is expressed to Oscar Fugalli for organizing and conducting the workshop; to the Sri Lanka Forest Department for local arrangements and support; and to Les W. Carlson, Canadian Forestry Service, and Keith R. Shea, U.S. Department of Agriculture Forest Service, who led the planning effort and compiled the final report.

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Special recognition is given to the discussion leaders, Omar M. Ali, R. S. Mathur, Salleh Mohd. Nor, and M. I. Sheikh; and the Rapporteurs, J. Burley, R. Levingston, K. R. Shepard, and P. J. Wood, whose untiring efforts and diligence made it possible to document the deliberations of the workshop. The contributions of Salleh Mohd. Nor, who also served as chairman of all plenary session, are greatly appreciated.

The enthusiasm and dedication of all participants who spent many long hours in deliberation are especially noteworthy. Without so much valuable input, the workshop would not have succeeded.

"A Blueprint for Action" is intended to provide guidelines for research to be pursued by participating countries and their institutions involved in research and development on multipurpose tree species and particularly for the establishment of 10 regional, species-oriented networks, to donor agencies for opportunities to fund selected projects and to other international agencies for information. The Kandy workshop represents a first step in defining the research needed to increase productivity of multipurpose tree species in Asian countries. Detailed plans now must be developed for each species network.

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Robert E. Buckman  
Vice President, IUFRO



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The Asian Region Workshop on "Increasing Productivity of Multipurpose Tree Species" held in Kandy, Sri Lanka, July 16–28, 1984, was the first of its kind. Additional workshops with similar objectives are being planned for Africa and Latin America. The 1984 workshop was organized by the International Union of Forestry Research Organizations (IUFRO) under the Special Program for Developing Countries as an outcome of the 1981 IUFRO Congress in Kyoto, Japan. A Special Program Coordinator, Oscar Fugalli, funded by the World Bank and the United Nations Development Program, organized the workshop and obtained additional funds from international agencies. Altogether, 46 people attended, including 25 participants from 12 Asian countries.

Intensive plantings of high-yielding, multipurpose tree species (MPTS) can markedly reduce the pressures on natural forests and contribute to the well-being of rural people throughout much of the Asian region.

There are a number of key problems or needs that can be addressed by appropriate use of MPTS:

- **Fuelwood.** In the Asian region, about 600 million people are experiencing an acute shortage of fuelwood. Either animal dung or crop residue is widely used for fuel or for maintaining and improving agricultural soil fertility. Research into fast-growing MPTS for farmland planting can ensure a supply of fuelwood as well as meet other needs of rural people.
- **Rehabilitation of Watersheds.** In many upland watersheds, past deforestation has resulted in massive soil erosion, sedimentation of dams and reservoirs, and increased flooding of downstream agricultural lands and communities. Development of technologies for sustaining production of MPTS could alleviate this situation and simultaneously supply wood for fuel, animal fodder, and other uses.
- **Rehabilitation of Degraded Lands.** Vast areas of former farmlands have become nonproductive as a result of poor cropping practices and use of manure and crop residue for fuel instead of for maintaining and improving agricultural soil fertility. Specially selected MPTS could provide fuelwood and fodder for animals and fix atmospheric nitrogen to improve soil fertility.
- **Income and Employment.** In general, the average annual per capita income throughout much of Asia is low, and the rural farmer is invariably at the lower end of the economic scale. Incorporating MPTS into farm practices could, through sale of fuelwood, forest products, and fruit, provide another source of income for these rural poor and contribute to the welfare of rural communities.
- **Agricultural Settlement in Tropical Rain Forests.** Expanding agricultural settlements in tropical rain forests are a growing problem. The low fertility of rain forest soils, and the attendant difficulty in devising suitable cropping systems, is fundamental to the overall problem. Development of MPTS, especially legumes, is a high priority to aid sustainable farming systems.



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There are a large number of trees that can be classed as multipurpose tree species. Consequently, there is much uncertainty as to the most appropriate species for particular climatic conditions and uses. Considerable diversity of species planted in social and rural forestry programs is essential. Research, development, and application technology is essential to define appropriate species, means for propagating and culturing them, and ways to introduce them into land management practices.

The Kandy workshop attempted to address the above problems and determine those species most suitable for study and use in land management practices. This workshop was divided into two parts: (1) Presentation of position papers and special papers, and (2) planning a program of research, development, and application for multipurpose tree species—a blueprint for action.

Position papers addressed four major discussion areas concerning MPTS:

- Research in tree improvement and propagation.
- Research in establishment and tending techniques.
- Research for the enhancement and maintenance of plant productivity.
- Research in silviculture and management.

Additional informal presentations and discussions were held on:

- Soil productivity.
- Land evaluation.
- Tree spacing.
- Development and operation of international networks.

These preparations and discussions provided the basis for a detailed planning effort in which all attendees participated.

The objective of the planning effort was to:

within an initial period of 10 years, develop and disseminate technology to increase productivity and usefulness of multipurpose tree species (MPTS) in sustainable land use systems to enhance the income and supplement the basic needs of rural people.

Seven subobjectives with specific goals, research activities, and subactivities were defined in greater detail along with estimated timeframes for completing them. The subobjectives were to:

- Select, genetically improve, and conserve MPTS.

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- Develop nursery establishment and tending techniques for MPTS.
  - Develop management systems for MPTS.
  - Develop protection systems for MPTS.
  - Develop techniques and systems for maintaining soil productivity.
  - Determine social, economic, and environmental aspects.
  - Provide for institutional support and common services.

From the myriad of potential species of multipurpose trees, those species of highest priority were selected for each of three major climatic zones in Southeast Asia—moist/wet, arid/semiarid and mountainous zones. These groupings were further refined into the top five to six species designated for each zone.

Another accomplishment of the workshop was development of 10 proposed species networks for Southeast Asia. Each network pertains to a species or a small group of species of highest priority. The participants proposed lead countries, participating countries, and lead and participating institutions. Potential participating international agencies and possible sources of funds were also identified. These proposed networks are the basis for further, more detailed planning and followup.

Using the information generated at the workshop, identifiable programs of research, development, and application can be organized and specific assignments of research activity developed. In fact, modules of research programs can be outlined for support by donor agencies. It is essential, however, that each network be subjected to further, more detailed analysis and planning to define specific projects and studies. This next step is needed for more precise program definition, assignment of responsibilities, and determination of costs.

Support of the networks by donor organizations is crucial. Most of the countries that could benefit from increased productivity from MPTS lack the human, financial, and physical resources necessary to establish the networks and carry out the required research.

The institutions, named in each species network, agreed to develop lead or supportive activities in the networks. Remaining is the question of a mechanism to ensure continued development of the blueprint for action and essential funding and coordination. It was recommended that IUFRO endeavor to secure funds for a position of facilitator of networks and research cooperation for tropical and subtropical Asia. The facilitator would work with the lead and participating institutions in the networks and with the governments, international agencies, and donor groups. Meantime, lead institutions and donor organizations should continue to move ahead with those portions of the blueprint for action of greatest interest and potential.



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In establishing networks, first priority should be given to recruitment of consultants among researchers in the Asian region. Where expertise does not exist, teams of local or expatriate consultants should be considered. Expatriate consultants who cannot devote full time or who come and go should not be recruited. Further detailed planning beyond that possible at the Kandy workshop is an essential next step to more sharply define the programs.

High priority for funding, both national and external, should be given to strengthening research capabilities within the region and secondly to supporting activities of other organizations, both within and outside the region, that could contribute to the networks.

In discussing networking in international agricultural research Plucknett and Smith<sup>1</sup> noted seven main principles for success that may be useful in developing networks. These principles are summarized below:

- The problem should be clearly defined and a realistic research agenda drawn up.
- The problem should be widely shared.
- Strong self-interest underpins effective networks; effective networks cannot be mandated.
- Participants must be willing to commit resources such as personnel and facilities.
- Outside funding must be available to facilitate birth of the networks and keep them functioning for at least the first few years.
- Participants must have sufficient training and expertise to make a contribution.
- Networks need to be guided by strong and efficient leaders who have the confidence of the participants.

The Kandy workshop provided a unique opportunity for the establishment of networks for research on MPTS in Southeast Asia. Rapid followup by participating countries, institutions, and donor agencies is essential if expectations are to be realized and appropriate programs developed to aid the rural poor. In order to succeed, both countries and donor agencies must give high priority to programs and budgets for MPTS.

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<sup>1</sup>Plucknett, D.L. and N.J.H. Smith. 1984. Networking in international agricultural research. *Science*, Vol. 225, No. 4666: 989–993.





The IUFRO Planning Workshop for Asia on forest research and technology transfer had as its theme, *Increasing Productivity of Multipurpose Tree Species*. The underlying problem was identified by participants as "insufficient local renewable resources to meet the needs of the people for products of multipurpose tree species," especially in the near future. This problem can be alleviated by increasing the productivity of multipurpose tree species (MPTS) for wood-based energy and other uses.

In the Asian region, MPT are, in fact, used to supply fuelwood for heating and cooking; fodder for farm animals; fruits for food; and fertilizer in the form of green manure and to fix atmospheric nitrogen; to provide protection from winds by shelterbelts and windbreaks; flowers for honey production; and other products, including resins, gums, furniture, and construction timber, that supplement the income of the rural farmers. As Dr. S.S. Puri, FAO Assistant Director-General/Regional Representative for Asia and the Pacific, noted in his keynote address, "The Role of Multipurpose Trees in Rural Development: The Need for Socio-economic Research," the role of MPTS simply cannot be overestimated. He further stated that countries that have neglected their forest resource also suffer from overall lower agricultural productivity, and produced statistics to substantiate his statement.

The dimensions of the underlying problem noted above can be illustrated by the following three issues:

### **The fuelwood crisis.**

In the Asian region, about 600 million people are experiencing an acute fuelwood scarcity. The lack of fuelwood forces them to burn either animal dung or crop residue that is needed to maintain and improve soil fertility. In India, the related reduction in soil fertility results in more than 15 million tons of lost food production a year. These countries must achieve at least a fivefold increase in the level of afforestation if they are to ensure the supplies of fuelwood or charcoal needed for both rural and urban populations by the year 2000.

Research into fast-growing MPTS for farmland plantings and reforestation of agricultural wastelands can ensure the availability of fuelwood and many other forest products needed by rural families, such as fruit, fodder, poles, and medicinal products. One area of research is in the reduction of costs of establishment by direct seeding techniques or of seedling planting systems. These techniques are needed to ensure rapid adoption of improved tree seed and seedlings by the more than 300 million farming families in the region who are the target group for multipurpose tree plantings. Also, more than 500 million landless people could be involved as cash crop tree farmers if an adequate supply of trees and land were available.

### **Rehabilitation of degraded watersheds.**

In upland watersheds, particularly those of Nepal, India, Indonesia, Pakistan, Philippines, and Thailand, past deforestation has led to massive increases in soil erosion, sedimentation of dams and reservoirs, and increased flooding causing loss of crops and, in extreme cases, human lives.

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The lives of some 200 million people are affected by this deteriorating land use situation, the underlying causes of which are related to pressure on forests and land resources as a result of rising population. About 75 million hectares of degraded watersheds need rehabilitation. Reforestation with fast-growing, multipurpose trees, particularly fodder/fuelwood species, and intensive protection and management of remaining resources are major issues for both forest policy and research.

A specific research topic that clearly has potential to make a major contribution in this area is the development of technologies for maximizing sustainable production of tree fodder and fuelwood using such techniques as lopping, pollarding, coppicing, and improving hedgerow management. Also, sociological research is needed to determine local perceptions of the usefulness of trees, on such critical matters as choice of species and attitudes on management and protection of natural forest resources.

#### **Agricultural settlement in tropical rain forests**

A third issue of major concern is the pressure of expanding agricultural settlements in tropical rain forests through such programs as Indonesia's Transmigration/Settlement Plans. The fundamental issue is the low fertility of rain forest soils and the attendant difficulties in devising sustainable cropping systems. A key research issue is the development of species to increase productivity of fruit, perennial agriculture crops, and forest trees (particularly the legumes) that aid sustainable farming systems. Research focussed on the improvement of soil fertility through increased use of leguminous species seems to be an obvious priority.

The seriousness of the problem is accentuated by the low rates of income in the region. For much of the region, the annual per capita income ranges from \$80 to \$300. In the smaller ASEAN group of countries, per capita income is substantially higher, \$420 to \$1,670, excluding Singapore which has a per capita income of \$4,480 (U.S.). These statistics refer to the population as a whole and do not take into account the invariably lower income of the majority of rural farmers. The estimated population in tropical/subtropical Asian rural farm communities, excluding China, is about 1.2 billion, which represents about 85 percent of the regional population. This population, however, is not equally distributed, nor are the same MPTS required in each region to improve the farming systems.



For the purposes of this workshop, South Asia, Southeast Asia, and the Pacific were divided into three major zones, two of which are associated with the number of annual growing days. The *moist/wet* zone, the largest and most populated, includes areas where the growing period for agricultural field crops is 150–365 days. Most of the countries in South and Southeast Asia are in this zone or are partly included in it. The *arid/semiarid* zone is described as an area where lack of rainfall limits growth of field crops to a range of 0–150 days a year. This zone includes Pakistan, parts of India, and very limited areas on some islands of Indonesia and the Philippines. A third category was set up to include the unique conditions of the *mountainous* zone of Asia. Although the primary country of concern in this zone is Nepal, others such as Pakistan, India, Malaysia, and the Philippines have mountainous areas that present similar problems for the use and development of MPTS. These three zones were used as the basis of discussions at the workshop and will be referred to frequently by their acronyms in this report: AS = arid/semi-arid; MW = moist/wet; and MZ = mountainous.

The research planning exercise that forms the basis for this report was preceded by the presentation of position papers during the first week of the workshop. These papers were intended to inform the participants of the level of knowledge in a particular field, identify gaps in knowledge, suggest research to be undertaken to narrow the gaps, and speculate on the potential application of new research. The attached copy of the workshop schedule (appendix I) lists the subjects covered. The details of the papers will be available in the final proceedings of the workshop.

The objective of the workshop was to develop a blueprint for action. This report provides the blueprint, outlines how it was developed, and proposes courses of action for increasing the productivity of MPTS.

After the presentation of position papers, the four discussion area leaders and the four rapporteurs met with the two planning leaders to review the planning process which would guide further planning. The planning process is a convergence analysis technique<sup>2</sup> used to determine objectives, identify distinct research activities, and develop a timeframe in which they can be done—in other words, to create a blueprint for action.

The needs (gaps) identified in the position papers and by the workshop participants were presented in the context of four discussion areas. From review of the discussion areas, the planning group developed an objective, 7 subobjectives, 21 goals, and 43 activities. These are shown in appendix II and further described in appendix III. The activities were further broken down into specific subactivities that could be undertaken within a specific timeframe as shown in appendix III.

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<sup>2</sup>Shea, Keith R. and Ned D. Bayley. 1976. A new approach for planning and coordination of a large project. In Proc. Div. VI, XVI IUFRO Congress, Norway, pp. 304–305.

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Participants from each country prepared a checklist for each activity in relation to a list of MPTS (appendix IV). The larger group of workshop participants then discussed which species in each zone needed work and which subjects were important to follow up. The species for each zone are listed in appendix V. Priorities derived from appendix IV slightly changed the initial priority ranking but generally not the significance of the top priority species. Summaries of the checklists by zone are shown in appendix VI for the top priority species and in appendix VII for the five top activities.

The priority species and activities that need research are shown in appendices VI and VII. It is felt that the greatest progress can be made through cooperative programs and networks of both forestry and nonforestry institutions, each working on specific areas of a program. The workshop developed 10 species-oriented networks as a response to this need (appendix VIII). It is crucial that donor support be identified as soon as possible in the development of these networks so as to capitalize on the impetus created by the workshop.

The species network concept, however useful, does not reflect the urgency of certain research activities in the region. As a result of discussions and special presentations made toward the end of the workshop, several activities were identified: 1) Nutrient cycling and soil productivity; 2) tree breeding; 3) nursery and plantation establishment techniques; 4) pests and diseases; 5) sociological research; 6) economic research; and 7) management, harvesting and marketing research. These activities are detailed in appendix IX and should be taken into consideration within the species-based networks.

The workshop also developed two additional subobjectives that were not fully evaluated. Subobjective 6 deals with the socioeconomic-environmental aspects of forestry programs, whereas subobjective 7 deals with the provision for institutional support and common services. Activities and subactivities relating to these subobjectives are summarized in appendix III. The shortness of this discussion does not reflect the impact of these activities on all research, as they are institutional issues more than technical issues. Nevertheless, these aspects must be considered in establishing the species-based networks.

The action plan does not stop with the development of networks but must have a model to work from if it is to be an active plan. Some networks, such as those for bamboo/rattan and *Leucaena*, already exist in one form or another, but could be organized and developed further. The use of the information from this workshop should be helpful in directing activity in those existing networks as a framework for the others.

Using information generated at the workshop and specifically the data in appendices III, IV, VII, and VIII, identifiable programs can be developed and specific assignments of research activity suggested. In fact, modules of research programs can be outlined for support by donor agencies. The blueprint for action for each of the 10 species networks can be developed further using appendix III subactivities as network building blocks. Appendix X gives an example of how a network might be developed for *Acacia*, using the data generated at the workshop. It recognizes the priorities shown in appendices VI and VII, (species and activities priorities), spells out lead responsibilities suggested in appendix VIII (networks), indicates subactivity research actions from appendix III, and suggests how some of the subactivities could be executed. Appendix III also provides a suggested timeframe for completion of the subactivities.

The time allotted to the workshop did not allow for the development of more specific subactivities. Indeed, it could not have gone to that point without the backup of a cadre of appropriate research scientists. It is therefore necessary for each network to go through further analysis to define more specific studies and projects to be carried out in the respective networks. This next step is an essential one for program definition, assignment of responsibilities, and cost determinations.



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The question of donor support is crucial, as most of the countries needing increased productivity from MPTS lack human, financial, or physical resources to carry out the necessary research. Donors should note closely the level of program and project definition, as some programs are open ended and others are well defined and could be completed easily. In any case, the second level of analysis planning beyond this workshop is an essential next step.

The institutions named in each network and represented at the workshop agreed to develop lead or supportive activities in the networks. Remaining is the question of what mechanism can ensure the continued development and use of the blueprint for action. Considerable discussion took place on this point and the suggestion was made that IUFRO should endeavor to secure funds for the creation of a position of facilitator of networks and research cooperation for tropical and subtropical Asia. This position would capitalize on the outputs of this workshop. The facilitator would work with lead and participating institutions, international agencies, governments, and donor groups.

Possible recommendations for immediate followup include the following:

1. Upon receipt of the blueprint for action, the lead institutions should contact the participating institutions in order to obtain the necessary information for formulating network action plans by July 1, 1985, for submission to donors.
2. The IUFRO should endeavor to secure funds for the creation of a position of facilitator of networks and research cooperation in tropical and subtropical Asia. The position should capitalize on the outputs of the workshop. The incumbent should work with government institutions, international agencies, and donors.
3. Emphasis should be directed at developing core species networks within the potential participating institutions.
4. IUFRO should develop a schedule of evaluation workshops over the next 10 years to monitor the progress of the network action plans and revise the blueprint as necessary.
5. The planning leaders should further document the blueprint development process for future reference when convergence analysis is used in defining broad research programs.

## Appendix I. Agenda—Planning Workshop on Forest Research and Technology Transfer

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*Day 1—a.m.*  
(Monday, July 16)

Opening Address by the Honorable Acting Minister of Lands and Land Development,  
A.M.S. Adikari

Address of Welcome by the Conservator of Forest, V.R. Nanayakkara

Keynote Address: "The role of multipurpose species in rural development: The need for socioeconomic research," by S.S. Puri, FAO Assistant Director-General/Regional Representative for Asia and the Pacific

Overview and training in planning techniques

Discussion Area 1: Research in Tree Improvement and Propagation

Position Paper 1.1: Identification and conservation of genetic resources

*Day 1—p.m.*

Position Paper 1.2: Species, provenance, and germ plasm trials

Position Paper 1.3: Quality seed production

Special Paper SP 1: National bioresource systems in Asia—Implications for policy and research

*Day 2—a.m.*  
(Tuesday, July 17)

Discussion Area 1 (Continued):

Position Paper 1.4: Vegetative propagation (cutting, tissue, culture, etc.)

Discussion Area 2: Research in Establishment and Tending Techniques

Position Paper 2.1: Site selection

*Day 2—p.m.*

Position Paper 2.2: Cost-effective methods of manual site preparation

Position Paper 2.3: Cost-effective methods of mechanical site preparation

*Day 3—a.m.*  
(Wednesday, July 18)

Discussion Area 2 (Continued):

Position Paper 2.4: Nursery practices

Position Paper 2.5: Planting techniques in relation to site and type of planting stock

*Day 3—p.m.*

Position Paper 2.6.: Timing and means of weed control

Discussion Area 3: Research for the Enhancement and Maintenance of Plant Productivity

Position Paper 3.1.: The role of nitrogen-fixing trees in soil biology

Special Paper SP 2: Natural regeneration options

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Day 4—a.m.  
(Thursday, July 19)

Discussion Area 3 (Continued):

Position Paper 3.2.: Chemical fertilization and its economic aspects

Position Paper 3.3.: Forest protection (against fire, animals, pests, and diseases)

Day 4—p.m.

Discussion Area 4: Research in Silviculture and Management

Position Paper 4.1.: Spacing and thinning, with particular reference to the production of biomass for energy

Position Paper 4.2.: Harvesting and transport systems: clearcutting and replanting, coppicing, pollarding, lopping

Special Paper SP 3: Experimental design for (a) species, provenance, and germ plasm trials, and (b) spacing and thinning trials (including some considerations on research philosophy and methods)

Day 5—a.m.  
(Friday, July 20)

Discussion Area 4 (Continued):

Position Paper 4.3.: Multipurpose tree species as components of agroforestry systems, including trees on agricultural land (e.g., boundary plantings, windbreaks)

Special Paper SP 4: Yield determination and forecasting

Days 6, 7, and 8  
(Saturday, Sunday, and  
Monday, July 21, 22, and  
23)

Study tour for participants (except discussion leaders, rapporteurs, and planning leaders)

Discussion leaders, rapporteurs, and planning leaders to:

- (a) review planning process
- (b) review reports from each discussion area (phase)
- (c) determine proposed program objectives and timeframe
- (d) establish proposed intermediate objectives for each phase
- (e) develop proposed activity flows (phases, subphases) and activities organized by arrays
- (f) develop proposed activity schedule
- (g) combine (b) to (f) above into a draft blueprint for action

*Days 9 to 13: Planning Workshop*

Day 9  
(Tuesday, July 24)

9.1 Convene plenary session

- 9.11 Review planning process
- 9.12 Review progress and status of draft blueprint for action
- 9.13 Agree upon objectives and timeframe for blueprint for action
- 9.14 Agree upon intermediate objectives for each phase/discussion area
- 9.15 Assign participants to phase/discussion areas



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Day 9  
(Tuesday, July 24)  
Continued

- 9.2 Convene separate sessions (one for each phase/discussion area)
- 9.3 Review progress and status (discussion leaders and rapporteurs)

Day 10  
(Wednesday, July 25)

- 10.1 Convene separate session (one for each phase/discussion area)
  - 10.11 Review Day 9 progress and revise as needed
  - 10.12 Continue to develop activity flow (subphases, activities arrays)
- 10.2 Review progress and status (discussion leaders and rapporteurs)

Day 11  
(Thursday, July 26)

- 11.1 Convene separate sessions (one for each phase/discussion area), also a brief plenary session if needed
  - 11.11 Review Day 10 progress and revise as needed
  - 11.12 Continue to develop activity flow
  - 11.13 Develop activity schedule (anticipated works and costs by year for each activity)

Day 12  
(Friday, July 27)

- 12.1 Convene separate sessions (one for each phase/discussion area), also a brief plenary session if needed
  - 12.11 Review Day 11 progress and revise activity flow and activity schedule as needed
  - 12.12 Prepare draft blueprint for action for each phase/discussion area and anticipated accomplishments
- 12.2 Review progress and status (discussion leaders and rapporteurs)

Day 13  
(Saturday, July 28)

- 13.1 Convene plenary session
  - 13.11 Present phase/discussion area blueprints for action for review, discussion, and revision
  - 13.12 Incorporate phase/discussion area blueprints for action into a draft overall blueprint for action
- 13.2 Close planning workshop
- 13.3 Vote of thanks
- 13.4 Evaluation (discussion leaders, rapporteurs, planning leaders)

**Post-Workshop Action:**

- 1. Finalize blueprint for action (planning leaders)
  - 1.1 Edit and revise blueprint
  - 1.2 Obtain reviews from discussion leaders and rapporteurs
  - 1.3 Incorporate comments into final blueprint for action
  - 1.4 Transmit blueprint to IUFRO
- 2. Distribute final blueprint for action (IUFRO)

## Appendix II: Summary of Objectives, Goals, and Activities for Improving Productivity of Multipurpose Species

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### Objective:

Within an initial period of 10 years, develop and disseminate technology to increase productivity and usefulness of multipurpose tree species (MPTS) in sustainable land use systems to enhance the income and supplement basic needs of rural people.

### Subobjective 1: *Select, Genetically Improve, and Conserve MPTS*

#### Goal 1.1 Choice of Species

Activity 1.1.1 Exploration

Activity 1.1.2 Evaluation

#### Goal 1.2 Genetic Improvement

Activity 1.2.1 Tree Breeding

Activity 1.2.2 Development of Vegetative Propagation

Activity 1.2.3 Seed Collection, Storage, and Testing

#### Goal 1.3 Conservation of Genetic Resources

Activity 1.3.1 *Ex situ* Conservation

Activity 1.3.2 *In situ* Conservation

### Subobjective 2: *Develop Nursery, Establishment, and Tending Techniques for MPTS*

#### Goal 2.1 Nursery Production

Activity 2.1.1 Improve Nursery Stock Production

#### Goal 2.2 Site Selection

Activity 2.2.1 Develop and Use Methods of Site Selection

#### Goal 2.3 Site Preparation

Activity 2.3.1 Technology Development

#### Goal 2.4 Establishment and Early Tending

Activity 2.4.1 Technique Development

#### Goal 2.5 Prioritise Activities

Activity 2.5.1 Priority Activities

### Subobjective 3: *Develop Management Systems for MPTS*

#### Goal 3.1 Silvics and Biomass Yield

Activity 3.1.1 Spacing, Thinning, and Rotation

Activity 3.1.2 Foliage Manipulation

Activity 3.1.3 Tree Species Mixtures

Activity 3.1.4 Water Consumption

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Goal 3.2 Agroforestry

- Activity 3.2.1 Tree/Crop Interface
- Activity 3.2.2 Silvo-pasture Development
- Activity 3.2.3 Tree Ideotype Identification
- Activity 3.2.4 Shelterbelts and Windbreaks
- Activity 3.2.5 Land Use Problem Diagnosis
- Activity 3.2.6 Irrigated Farming Systems
- Activity 3.2.7 Mangrove Management

Goal 3.3 Natural Regeneration

- Activity 3.3.1 Seeding, Root Suckering, and/or Coppicing

Goal 3.4 Harvesting and Transport

- Activity 3.4.1 Tools and Ergonomics
- Activity 3.4.2 Utilization

Goal 3.5 Marketing and Economics

- Activity 3.5.1 Marketing Small Quantities of Produce
- Activity 3.5.2 Tree Production Economics

**Subobjective 4:** *Develop protection systems for MPTS*

Goal 4.1 Pest Management Systems

- Activity 4.1.1 Pest Biology and Control

Goal 4.2 Fire Protection

- Activity 4.2.1 Rural Fire Prevention and Protection Systems

Goal 4.3 Protection from Animals

- Activity 4.3.1 Animal Damage

**Subobjective 5:** *Develop Techniques and Systems for Maintaining and Improving Soil Productivity*

Goal 5.1 N-Fixing Organisms

- Activity 5.1.1 Culture and Inoculation Methods
- Activity 5.1.2 Effects on Soil Productivity

Goal 5.2 Nutrient Cycling and Nutrient Flux

- Activity 5.2.1 Nutrient Cycling and Nutrient Flux

**Subobjective 6:** *Determine Social, Economic, and Environmental Aspects*

Goal 6.1 Environmental Impact Analysis (EIA)

- Activity 6.1.1 Application of EIA Techniques



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Goal 6.2 Socioeconomic Studies

Activity 6.2.1 Supply and Demand and Farmers' Perceptions

Activity 6.2.2 Monitoring and Evaluation

**Subobjective 7:** *Provide for Institutional Support and Common Services*

Goal 7.1 Education, Training, and Extension

Activity 7.1.1 Professional Education and Training

Activity 7.1.2 Technical Training

Activity 7.1.3 Extension

Goal 7.2 Information Provision

Activity 7.2.1 Utilize Existing Information

Activity 7.2.2 Increase Awareness of Published Information

Activity 7.2.3 Create and Maintain Data Bases

Activity 7.2.4 Involve IUFRO Research Groups

**Priorities by Subobjectives**    **Subobjective 1:** *Select Genetically Improve and Conserve MPTS (Priorities depend on species)*

High Priority:    Goal 1.1—Choice of Species  
                            1.2—Genetic Improvement  
                                    Activity 1.2.1    Tree Breeding  
                                    Activity 1.2.2    Vegetative Propagation

Low Priority:    Goal 1.3—Conservation of Genetic Resource

**Subobjective 2:** *Develop Nursery, Establishment, and Tending Techniques.*

High Priority:    Goal 2.5—Prioritised Activities  
                                    Activity 2.5.1.1 Review Past and Present Work  
  2.5.1.2 Disseminate and Transfer Information  
  2.5.1.3 Seed Collection Methods  
  2.5.1.4 Site Selection Methods  
  2.5.1.5 Site Preparation Techniques  
  2.5.1.6 Species Establishment Methods  
  2.5.1.7 Establishment Techniques

**Subobjective 3:** *Develop Management Systems for MPTS*

High Priority:    Goal 3.1—Silvics and Biomass Yield  
                                    Activity 3.1.1    Spacing, Thinning, and Rotation  
  3.1.4    Water Consumption

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Goal 3.2—Agroforestry

- Activity 3.2.1 Tree/Crop Interface
- 3.2.4 Shelterbelts and Windbreaks
- 3.2.5 Land Use Problem Diagnosis
- 3.2.6 Irrigated Farming Systems

Goal 3.5—Marketing and Economics

- Activity 3.5.2 Tree Production Economics

Medium Priority: Goal 3.1—Silvic and Biomass Yield

- Activity 3.1.3 Tree Species Mixtures

Low Priority: Goal 3.2—Agroforestry

- Activity 3.2.3 Tree Ideotype Identification

Goal 3.4—Harvesting and Transplant

- Activity 3.4.1 Tools and Ergonomics

**Subobjective 4:** *Develop Pest Management Systems for Key Pests and Diseases*

High Priority: Goal 4.1—Pest Management Systems

- Activity 4.1.1.1 Information Retrieval System
- 4.1.1.2 Appraisal of Pest Damage

**Subobjective 5:** *Develop Techniques and Systems for Maintaining and Improving Soil Productivity*

High Priority: Goal 5.1—Nitrogen-Fixing Organisms

- Activity 5.1.1 Culture and Inoculation Methods
  - 5.1.1.1 Apply Existing Technology
  - 5.1.1.2 Establish and Staff Laboratories
- Activity 5.1.2 Effects on Soil Productivity
  - 5.1.2.1 Assessment of Nitrogen-fixing MPT Species
  - 5.1.2.2 Survey and Evaluate Existing Use of N-Fixing Species
  - 5.1.2.3 Field Evaluation Trials
  - 5.1.2.4 Long-Term Trials—N Cycle and Organic Matter
- 5.2.1 Nutrient Cycling and Flux
  - 5.2.1.1 Survey Literature and Develop Guidelines
  - 5.2.1.2 Laboratory for Soil and Plant Analyses
  - 5.2.1.3 Inventory Soil Nutrients
  - 5.2.1.4 Fertilizer Experiments

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**Subobjective 6:** *Determine Social, Economic, and Environmental Aspects*  
(Priorities not established)

**Subobjective 7:** *Provide Institutional Support and Common Services*  
(Priorities not established)



### Appendix III: Subobjectives, Goals, Activities, and Subactivities

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The workshop objective was further subdivided into seven subobjectives, one to several goals, and major activities. The major activities lead to definition of specific subactivities, each with a brief description and projected outputs. For convenience, the subactivities were grouped, when appropriate, as follows:

**Lead Activities.** The main effort, most likely to achieve the subobjective successfully and quickly based on available knowledge.

**Safeguard Activities.** Those activities that are the most likely substitute technical approaches to the lead activities. Essentially, they protect the outcome.

**Optimising Activities.** Those activities that could enhance the potential of lead activities in achieving the subobjective.

**Supplementary Activities.** Those activities that are long term or high risk in nature but which if successful could bring about major breakthroughs or greatly enhance the outcome.

The participants also estimated the time when each subactivity should begin and end. This information is useful for determining the sequence of subactivities and those most likely to provide quick payoff and those that must be carried forward or continued over a number of years.

**Subobjective 1:** *Select, genetically improve, and conserve multipurpose tree species.*

For almost any site there are many MPTS that could survive and yield products or services; the major improvement that can be made in overall productivity arises from correct, precise choice of the optimum species and seed source (natural or derived provenance). This requires intensive review of current knowledge and systematic sampling both in the natural range and, where a species was introduced several generations ago, in the exotic locations also.

Once the optimum seed source is known for a given site type, productivity can be improved dramatically by classical tree breeding techniques with strategies that provide for continued improvement over several generations and for flexibility to meet changing pests, markets, or sites. A significant genetic improvement can be made in the first generation by using vegetative propagation to capture specific combining ability effects in selected trees. However, seed propagation will always be required, and one priority is to develop appropriate seed handling systems for each species.

In support of these activities and to allow future human generations some flexibility in their decisions, genetic resource conservation is required. This can be achieved through *in situ* natural stands and *ex situ* seed stands, seed banks, tissue culture banks, and clonal activities.

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**Subobjective 1:** *Select, Genetically Improve, and Conserve MPTS.*

---

**Goal:** 1.1 Choice of Species

---

**Activity:** 1.1.1 Exploration

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
1.1.1.1	Agree on small number of well-proved species for each zone (“primary species”). Output: List of species. <sup>1</sup>	X										
1.1.1.2	Review global literature, data sources, and existing plantings of these primary species. Output: Species monographs.	X	X									
1.1.1.3	Field exploration of natural and exotic ranges of these primary species, including mapping and sample collection. Output: Maps, seed, herbarium samples, and microbial samples subject to quarantine regulations.		X	X	X	X						
<i>Safeguard</i>												
1.1.1.4	Review global literature, data sources, and existing trials to identify other promising species (“secondary species”). Output: Lists of species and monographs.		X	X	X							
1.1.1.5	Homoclimal comparison to suggest possible less known secondary species. Output: Lists of species.		X									
1.1.1.6	Field exploration of natural and exotic ranges of these secondary species including mapping and sample collection combined with 1.1.1.3 where possible. Output: Maps, seed, herbarium samples, microbial samples.		X	X	X	X	X	X	X	X	X	X
<i>Optimizing</i>												
1.1.1.7	Create and expand literature and computerized data bases for all species. Output: International information retrieval system.	X	X	X	X	X	X	X	X	X	X	X

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<sup>1</sup>These were prepared for three zones at the planning workshop. (See appendix V)

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**Subobjective 1: Select, Genetically Improve, and Conserve MPTS.**

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**Goal: 1.1 Choice of Species**

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**Activity: 1.1.2 Evaluation**

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
1.1.2.1	Design species/provenance trials of primary species. Output: Designs and management/assessment prescriptions.		X	X	X	X					
1.1.2.2	Lay out and assess trials in nursery and field on range of site types and with varying silvicultural treatments. Output: Data.	X	X	X	X	X	X	X	X	X	X
1.1.2.3	Collect and analyze laboratory samples (e.g., fodder acceptability, fodder digestibility, fruit production calorific values). Output: Data.	X	X	X	X	X	X	X	X	X	X
1.1.2.4	Analyze all national data. Output: Choice of optimum species for each major site type.						X	X	X	X	X
<i>Safeguard</i>											
1.1.2.5	Design species/provenance trials of secondary species. Output: Designs and management/assessment prescriptions.			X	X	X	X				
1.1.2.6	Lay out and assess trials in nursery and field on range of site types and with varying silvicultural treatments. Output: Data.			X	X	X	X	X	X	X	X
1.1.2.7	Collect and analyze laboratory samples. Output: Data.			X	X	X	X	X	X	X	X
1.1.2.8	Analyze all national data. Output: Choice of optimum species for each major site type.						X	X	X	X	X
<i>Optimizing</i>											
1.1.2.9	International analysis of data from collaborative trials of primary species. Output: Information on species/provenance interaction with site effects and on seed source stability; data added to international data base.				X	X	X	X	X	X	X



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**Subobjective 1:** *Select, Genetically Improve, and Conserve MPTS.*

---

**Goal:** 1.1 Choice of Species

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**Activity:** 1.1.2 Evaluation (Continued)

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Optimizing</i> 1.1.2.10	International analysis of data from collaborative trials of secondary species. Output: Information on species/provenance interaction with site effects and on seed source stability; data added to international data base.					X	X	X	X	X	X
<i>Supplementary</i> 1.1.2.11	Analyze herbarium material from natural origins. Output: Data and monographs.			X	X	X	X				
1.1.2.12	Analyze herbarium material from existing and new provenance trials. Output: Data and monographs.			X	X	X	X				

---

**Subobjective 1:** *Select, Genetically Improve, and Conserve MPTS.*

---

**Goal:** 1.2 Genetic Improvement

---

**Activity:** 1.2.1 Tree Breeding

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	

Lead												
1.2.1.1	Identify, demarcate, and collect seed from superior stands, isolated groups, and/or single trees. Output: Secure supplies of marginally improved seed.	X	X	X	X	X						
1.2.1.2	Design, lay out, and assess (field and laboratory samples) progeny trials on major site types. Output: Data.			X	X	X	X	X	X	X	X	X
1.2.1.3	Analyze data nationally. Output: Determination of parental selections and genetic parameters to develop breeding strategy.								X	X	X	X
1.2.1.4	Create clonal and/or seedling seed orchards. Output: Genetically improved seed.		X	X	X	X	X					
1.2.1.5	Create clonal archives. Output: Secure genetic base.		X	X	X	X	X					
1.2.1.6	Design, lay out, and assess clonal tests where vegetative propagation is routine. Output: Improved clones.				X	X	X	X	X	X	X	X
Optimizing												
1.2.1.7	Analyze data internationally from collaborative progeny trials. Output: Information on genotype/environment interaction and genotype stability; international data base.									X	X	X
1.2.1.8	Create international breeding population. Output: Secure improved genotypes in several locations, available for all collaborators to incorporate in national programmes.					X	X					

---

**Subobjective 1:** *Select, Genetically Improve, and Conserve MPTS.*

---

**Goal:** 1.2 Genetic Improvement

---

**Activity:** 1.2.1 Tree Breeding (Continued)

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Supplementary</i>											
1.2.1.9	Hybridize selected species. Output: New genotypes.						X	X	X	X	X
1.2.1.10	Induced mutation (for disease resistance) and polyploidy (for growth rate). Output: New genotypes.						X	X	X	X	X



---

**Subobjective 1:** *Select, Genetically Improve, and Conserve MPTS.*

---

**Goal:** 1.2 Genetic Improvement

---

**Activity:** 1.2.2 Vegetative Propagation

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
1.2.2.1	Review available information. Output: Choice of likely methods.	X										
1.2.2.2	Develop methods for rooting cuttings including tests of ortet age, rejuvenation by coppicing and grafting, effects of topophysis and cyclophysis, and standard hormones and environmental conditions of light, temperature, water, and soil medium. Output: Routine economic method of rooting cuttings.	X	X	X	X	X						
<i>Optimizing</i>												
1.2.2.3	Test other hormones and growth regulators. Output: Improved methods for difficult species.		X	X	X	X						
1.2.2.4	Test other environmental conditions (e.g., light quality, photoperiod, soil media). Output: Improved methods for difficult species.		X	X	X	X						
<i>Supplementary</i>												
1.2.2.5	Develop micropropagation and tissue culture methods. Output: Improved propagation economy, international exchange of improved genotypes, conservation.							X	X	X		

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**Subobjective 1:** *Select, Genetically Improve, and Conserve MPTS.*

---

**Goal:** 1.2 Genetic Improvement

---

**Activity:** 1.2.3 Seed Collection, Storage, and Testing

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
1.2.3.1	Review literature and other information sources for primary species. Output: Existing information compilation.	X										
1.2.3.2	Review literature and other information sources for secondary species. Output: Existing information compilation.	X	X									
1.2.3.3	Conduct studies of phenology of flower, seed, and fruit. Output: National and zonal calendars.	X	X	X								
1.2.3.4	Conduct studies of methods for seed collection, temporary storage, transport, extraction, and drying. Output: Optimum methods of seed handling.		X	X	X							
1.2.3.5	Establish seed store and laboratory; conduct tests of storage conditions that affect seed viability. Output: Facilities and optimum methods of seed storage.	X	X	X	X							
<i>Safeguard</i>												
1.2.3.7	Conduct trails of vacuum freeze drying for storage. Output: Improved methods for difficult species.		X	X	X	X						
1.2.3.8	Conduct trails of inert gas storage. Output: Improved methods of storage.		X	X	X	X						
<i>Optimizing</i>												
1.2.3.9	Produce seed manual. Output: Manual.						X	X				

---

**Subobjective 1:** *Select, Genetically Improve, and Conserve MPTS.*

---

**Goal:** 1.3 Conservation of Genetic Resources

---

**Activity:** 1.3.1 *Ex Situ* Conservation

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<hr/>												
<i>Lead</i>												
1.3.1.1	Establish seed gene banks. Output: Gene banks.		X	X								
1.3.1.2	Create <i>ex situ</i> conservation stands. Output: Stands for national and/or regional use.		X	X	X							
<i>Safeguard</i>												
1.3.1.3	Create plots in arboreta and botanic gardens. Output: Increased genetic security and public/scientist display.											
<i>Optimizing</i>												
1.3.1.4	Conduct isozyme and other genetic studies to determine optimum stand size or tree numbers for conservation. Output: Basic information.				X	X	X					
<i>Supplementary</i>												
1.3.1.5	Tissue culture selected and/or tested genotypes. Output: Increased genetic security and availability.									X	X	X
1.3.1.6	Establish international data base of <i>ex situ</i> conservation activities. Output: Data base.	X	X	X	X	X	X	X	X	X	X	X



---

**Subobjective 1:** *Select, Genetically Improve, and Conserve MPTS.*

---

**Goal:** 1.3 Conservation of Genetic Resources

---

**Activity:** 1.3.2 *In Situ* Conservation

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<hr/>												
<i>Lead</i>												
1.3.2.1	Identify and demarcate natural (and naturalized) <i>in situ</i> conservation stands (relating where possible to MAB biosphere reserves and IUCN/WWF World Conservation Strategy). Output: Stands for national and/or regional supply of genetic resources.			X	X	X						
<i>Optimizing</i>												
1.3.2.2	Conduct isozyme and other genetic studies to determine optimum stand size. Output: Basic information.					X	X	X				
<i>Supplementary</i>												
1.3.2.3	Establish international data base <i>in situ</i> conservation stands. Output: Data base.			X	X	X	X	X	X	X	X	X

---

**Subobjective 2:** *Develop Nursery, Establishment, and Tending Techniques for MPTS.*

*This subobjective attempts to solve the problem of nonavailability of standard nursery stock of the MPTS and the lack of adequate well-documented knowledge of tree crops establishment on a vast variety and gradient of sites. It is proposed to develop practical, economical, and foolproof techniques of raising the desired species to ensure maximum survival and growth with a view to helping farmers with additional income to improve their lot.*

**Subobjective 2:** *Develop Nursery, Establishment, and Tending Techniques for MPTS.*

---

**Goal:** 2.1 To Develop the Most Practical Cost-Effective Techniques for Producing Nursery Stock of MPTS.

---

**Activity:** 2.1.1 Improve and Standardize Existing Methods and Develop New Methods for the Production of Nursery Stock for Large- and Small-Scale Plantings.

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<hr/>												
<i>Lead</i>												
2.1.1.1	Review past and current work on seed collection, storage, testing pretreatment, sowing methods, and containerization. Output: Data for dissemination.	X	X	X								
2.1.1.2	Disseminate information and transfer technology through training and technical assistance. Output: Data, guidelines, and manuals.			X	X	X						
<i>Safeguard</i>												
2.1.1.3	Improve and widen existing technology of vegetative propagation to supplement supplies of planting stock in the event of seed shortages. Output: Increased and more reliable supplies of planting stock.			X	X	X	X	X				
<i>Optimizing</i>												
2.1.1.4	Develop improved techniques on seed handling, soil mixtures, long-term soil management and water regime studies (root pruning), nursery hygiene, transportation of stock, and cost evaluation systems. Develop standardized grading methods for plant quality. Output: Improved, cheaper nursery stock.				X	X	X	X	X			

---

**Subobjective 2:** *Develop Nursery, Establishment, and Tending Technique for MPTS.*

---

**Goal:** 2.1 To Develop the Most Practical Cost-Effective Techniques for Producing Nursery Stock of MPTS.

---

**Activity:** 2.1.1 Improve and Standardize Existing Methods and Develop New Methods for the Production of Nursery Stock for Large- and Small-Scale Plantings.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+

---

*Supplementary*

2.1.1.5	Identify further suitable and reliable local sources of seed and material for vegetative propagation and develop local storage facilities and a convention for exchange of propagules. Output: More reliable supplies of seed, vegetative material, and other planting stock.	X	X	X	X	X					
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**Subobjective 2:** *Develop Nursery, Establishment, and Tending Technique for MPTS.*

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**Goal:** 2.2 Institute Use of and Standardize Methods of Site Selection.

---

**Activity:** 2.2.1 Develop and Use Methods of Site Selection vis-a-vis Their Suitability for Afforestation and Tree Planting.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
2.2.1.1	Review the results of past and ongoing research on site selection and analyze existing methods including those involving use of remote sensing/aerial photography; standardize methodology. Output: Data for dissemination.	X	X	X							
2.2.1.2	Disseminate information from investigations, introduce training of field and research organizations in concepts and methodology. Output: Transfer of technology.				X	X	X				
<i>Optimizing</i>											
2.2.1.3	Test and improve techniques for site classification in collaboration with other organizations. Output: Achievement of site classification.				X	X	X	X	X		
2.2.1.4	Establish a unit within tropical Asia for coordinating and disseminating information on site selection for MPT productivity. Output: Exchange of information and methodology.				X	X	X	X	X		
<i>Supplementary</i>											
2.2.1.5	Identify plant/soil condition indicator association for assessment of salinity, hydromorphism and aridity, and soil depth. Output: Data facilitating site classification.	X	X	X	X						

---

**Subobjective 2:** *Develop Nursery, Establishment, and Tending Techniques for MPTS.*

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**Goal:** 2.3 To Develop the Most Practical Cost-Effective Techniques for Site Preparation.

---

**Activity:** 2.3.1 Develop Economic Technologies of Site Preparation Appropriate for the Zones Envisaged.

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
2.3.1.1	Review current research and practices on site-related methods of land clearing, leveling, trenching, terracing, and soil cultivation using both manual and mechanical methods. Output: Collection of data.	X	X									
2.3.1.2	Dissemination of technology through demonstration, training, and exchange of information including mechanical equipment. Output: Transfer of technology.				X	X	X					
<i>Safeguard</i>												
2.3.1.3	Compare effects of different methods of site preparation on soil condition and productivity in liaison with current international work. Output: Data for relevant selection of techniques.			X	X	X	X	X				
<i>Optimizing</i>												
2.3.1.4	Develop improved techniques of site preparation, including precultivation green manuring, and improved use of tools, equipment, and machinery combined with evaluation of costs. Output: Improved and more economic techniques.			X	X	X	X	X				
<i>Supplementary</i>												
2.3.1.5	Develop methods of site preparation combining mechanization/manual methods, and extending the range of mechanization to wetter or steeper sites. Output: Improved, more effective site preparation.	X	X	X	X	X						
2.3.1.6	Updating information on mechanical equipment for site preparation. Output: Increased knowledge on mechanization.				X	X	X	X	X			

---

**Subobjective 2:** *Develop Nursery, Establishment, and Tending Techniques for MPTS.*

---

**Goal:** 2.4 To Develop the Most Practical Cost-Effective Methods for MPT Establishment and Early Tending.

---

**Activity:** 2.4.1 Development of the Most Effective and Economically-Viable Techniques for Tree Establishment and Maintenance on a Wide Range of Sites.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
2.4.1.1	Review available information and current research on establishment of crops. Output: Updated information.	X	X	X							
2.4.1.2	Dissemination of information and transfer of technology at vocational and technical level by demonstration and training. Output: Transfer of technology.		X	X	X						
<i>Optimizing</i>											
2.4.1.3	Lay out studies of species related to establishment methods including aspects of direct sowing, type, age, size of planting stock; time of planting/sowing and restocking; water requirements; planting densities for weed suppression and use of weedicides; timing/frequency, manual, chemical, and mechanical methods of early tending/and productive measures. Evaluate and compare costs. Output: Cost/benefit data on species performance by site preparation method.		X	X	X	X	X				
2.4.1.4	Develop techniques of MPT establishment appropriate for use by farmers. Output: Appropriate technology.	X	X	X	X						
2.4.1.5	Develop techniques for cheap direct sowing for use by farmers. Output: Appropriate technology.	X	X	X							

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**Subobjective 2:** *Develop Nursery, Establishment, and Tending Techniques for MPTS.*

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**Goal:** 2.4 To Develop the Most Practical Cost-Effective Methods for MPT Establishment and Early Tending.

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**Activity:** 2.4.1 Development of the Most Effective and Economically-Viable Techniques for Tree Establishment and Maintenance on a Wide Range of Sites.

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<hr/>												
<i>Supplementary</i>												
2.4.1.6	Followup studies of performance of species established by different methods as well as continued testing over a long period and introduction of new species and methods of establishment. Output: Data on species performance by sites and under climatic and disease stresses.					X	X	X	X	X		



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**Subobjective 2:** *Develop Nursery, Establishment, and Tending Techniques for MPTS.*

---

**Goal:** 2.5 Prioritize Activities from Section 2.

---

**Activity:** 2.5.1 Prioritize Subactivities

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<hr/>												
Lead												
2.5.1.1	Review past and current work on the most practical, cost-effective techniques for producing nursery stock, use and standardization of methods of site selection, techniques for site preparation, and establishment of MPTS.											
2.5.1.2	Disseminate and transfer concepts and methodology (site selection); disseminate and transfer technology (nursery, site preparation, establishment, and early tending) through publications, demonstrations, vocational and technical training, exchange of information, and inclusion in professional curriculae.											
2.5.1.3	Evolve appropriate technology for seed collection and handling (storage, testing, pre-treatment), exchange of seed and other propagules leading to production of healthy, sturdy, well-graded, and cheap planting stock of MPTS.											
2.5.1.4	Evolve and implement a simple and effective methodology for site selection.											
2.5.1.5	Evolve the most practical and cost-effective combinations of site preparation techniques involving manual, mechanical, and biological methods through trial and comparison over a wide range of site gradients.											
2.5.1.6	Lay out studies of species related to particular establishment methods including the following: water requirements of species under arid to dry ecological conditions; type, age, size, and period of planting seedlings; and early tending including weed control as well as protective measures.											

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**Subobjective 2:** *Develop Nursery, Establishment, and Tending Techniques for MPTS.*

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**Goal:** 2.5 Prioritize Activities from Section 2.

---

**Activity:** 2.5.1 Prioritize Subactivities (Continued)

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i> 2.5.1.7	Develop techniques of MPTS establishment appropriate for use by farmers.										

---

**Subobjective 3: Develop Management Systems for MPTS.**

Multipurpose trees are widely used in land-use systems throughout the region. Improvements in yield and usefulness can be made at several stages. The research proposed aims at plantations for maximum biomass production (mainly wood), at the management of trees for fodder, at mixtures of trees with crops and for animals (agroforestry), and at regeneration of existing stands of trees. The management and economics of harvesting and marketing, particularly of small quantities of produce from scattered areas, would also receive attention.

**Subobjective 3: Develop Management Systems for MPTS.**

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**Goal: 3.1 Increasing Biomass Yield Through Improved Silviculture and Management.**

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**Activity: 3.1.1 Spacing, Thinning, and Rotation Trials for Biomass Production.****Priority 1**

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
3.1.1.1	Examine and disseminate existing information on spacing and thinning trials. Output: Practical guidelines, spacing and thinning schedules.	X	X									
3.1.1.2	Establish standardized spacing trails covering the range from dense to free growth (including ideotype studies). Output: Information on optimum spacing for species and specific objectives and individual tree growth.	X	X	X	X	X	X	X	X	X	X	X
<i>Optimizing</i>												
3.1.1.3	Establish experiments on direct sowing. Output: Information on cheap establishment methods.	X	X	X								
3.1.1.4	Establish standardized thinning trials on existing plantations amenable to such trials. Output: Guidelines on thinning.	X	X	X	X	X	X	X	X	X	X	X

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.1 Increasing Biomass Yield Through Improved Silviculture and Management.

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**Activity:** 3.1.2 Foliage Manipulation—Pollarding, Pruning, Lopping, Coppicing, Suckering, and Hedgerows.

**Priority 1**

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<hr/>												
<i>Lead</i>												
3.1.2.1	Document and evaluate farmers' and foresters' experiences of method, intensity, pattern, frequency, and season. Output: Record of current practices.	X	X									
3.1.2.2	Initiate standardized trials on existing trees and subsequently on improved stock including studies on nutrient flows (cross-refer to 5). Output: Prescriptions.	X	X	X								
<i>Supplementary</i>												
3.1.2.3	Evaluate use of chemicals. Output: Chemicals for enhancement/inhibition of tree growth.	X	X	X								



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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.1 Increasing Biomass Yield Through Improved Silviculture and Management.

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**Activity:** 3.1.3 Tree Species Mixtures.

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**Priority 2**

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
3.1.3.1	Document and evaluate existing practices of farmers. Output: Documentation.	X	X									
3.1.3.2	Evaluate and disseminate existing information on tree species mixtures. Output: Documentation.	X	X									
<i>Optimizing</i>												
3.1.3.3	Conduct standardized trials of tree species mixtures. Output: Technology.	X	X	X	X							

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.1 Increasing Biomass Yield Through Improved Silviculture and Management.

---

**Activity:** 3.1.4 Water Consumption.

**Priority 1**

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
3.1.4.1	Evaluate and disseminate existing information on water consumption by trees. Output: Documentation.	X										
<i>Optimizing</i>												
3.1.4.2	Establish experiments in existing plantations to determine water uptake by trees. Output: Scientific information.	X	X	X								
3.1.4.3	Evaluate and disseminate methodology techniques for water consumption/stress evaluation. Output: Manual.	X	X	X								
<i>Supplementary</i>												
3.1.4.4	Determine water-tree relationships. Output: Basic scientific information.	X	X	X	X	X	X					

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.2 Agroforestry: Design of Practical Systems for Various Land Use Objectives.

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**Activity:** 3.2.1 Tree/Crop Interface Studies, Including Allelopathy and Tree/Crop Spacing Designs.**Priority 1**

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
3.2.1.1	Examine existing farm systems for tree/crop interface effects. Output: List of known effects for further study.	X	X	X								
3.2.1.2	Establish plots for interface studies using most common crops. Test hedges of suitable species. Output: Site-specific designs for farmers' objectives.	X	X	X	X							
<i>Optimizing</i>												
3.2.1.3	Where allelopathic effects found, examine leaves and roots for chemical exudates. Output: List of tree/crop interactions for (a) design and (b) analysis of chemicals.			X	X	X	X	X	X	X	X	X
3.2.1.4	Test range of spacing/crop designs on selected farms. Output: Detailed input/output and economic analysis (cross-refer to 3.5.2) case studies.			X	X	X	X	X	X	X	X	X
<i>Supplementary</i>												
3.2.1.5	Analysis of allelopathic chemicals. Output: Data.											

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.2 Agroforestry.

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**Activity:** 3.2.2 Silvo-Pasture Development: Design of Optimal Systems  
Incorporating Animals, Grazing, and Trees.

**Priority 2**

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
3.2.2.1	Evaluate and disseminate existing knowledge on herbaceous and tree fodder plants including yields on different sites and stock carrying capacity. Output: Literature collection and guidelines.	X	X									
3.2.2.2	Establish observation plots in existing plantations. Output: Fodder production, effects on soil, and stocking patterns.	X	X									
<i>Optimizing</i>												
3.2.2.3	Establish selected tree/grazing combinations (spacing and herbaceous covers). Output: Stocking levels, fodder production, and tree management.	X	X	X	X	X	X	X	X	X	X	X
3.2.2.4	Study seasonality of fodder outputs, palatability, and nutrition. Output: Information for stocking and harvesting strategies.	X	X	X	X	X	X	X	X	X	X	X



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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.2 Agroforestry.

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**Activity:** 3.2.3 Identification of Tree Ideotypes, Including Root and Crown Architecture.

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**Priority 3**

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i> 3.2.3.1	Examine existing plantations and naturally occurring trees for variability. Output: Describe ideotypes.	X	X								
<i>Optimizing</i> 3.2.3.2	Test selected ideotypes in field designs. Output: Information for planting designs and breeding strategy.			X	X	X	X	X	X	X	X
<i>Supplementary</i> 3.2.3.3	Examine elected ideotypes for root architecture.	X	X	X	X						

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.2 Agroforestry.

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**Activity:** 3.2.4 Design of Shelterbelts and Windbreaks.

**Priority 3**

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<hr/>											
<i>Lead</i>											
3.2.4.1	Evaluate and disseminate experience of designs and species. Field survey if needed of existing designs. Output: Information and documentation.	X	X								
3.2.4.2	Following examination of species characteristics (silvics plus ideotypes) (cross-refer to 3.2.3. and 3.1), prepare suitable designs to meet specified local conditions. Output: Prescriptions for field use.					X	X	X			
<i>Optimizing</i>											
3.2.4.3	Test range of designs in range of condition. Output: Refining of prescriptions.					X	X	X	X	X	X

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.2 Agroforestry

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**Activity:** 3.2.5 Diagnosis of Land Use and Farmer Problems  
(cross-reference: subobjective 6).**Priority 1**

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
3.2.5.1	Examine International Council for Research in Agroforestry (ICRAF) world inventory of traditional AF systems. Analyze for local conditions. Disseminate. Output: Information.	X	X									
3.2.5.2	Examine ICRAF diagnosis and design (D&D) methodology and modify for local conditions. Compare with other systems. Output: Recommendations for field surveys and diagnosis.	X	X									
<i>Optimizing</i>												
3.2.5.3	Apply the methodology in selected area. Output: Definition of problems, examination of probable solutions against other parts of the research program.		X	X	X							

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.2 Agroforestry

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**Activity:** 3.2.6 Growth of MPTS in Irrigated Farming Systems.

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**Priority 1**

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
3.2.6.1	Evaluate and disseminate experience on irrigated plantations. Review existing farm plantations on irrigated land. Output: Documentation of current practices.	X	X									
3.2.6.2	Examine economics of pure irrigated cash crop tree farming for farmers (cross-refer to 3.5.2). Output: Information for research priorities.			X	X	X	X	X	X	X	X	X
<i>Optimizing</i>												
3.2.6.3	Establish standardized trials as recommended in 3.1.1 in selected farmers' fields, including interactions with crops. Output: Information, technology.			X	X	X						



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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.3 Natural Regeneration of Existing Stands.

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**Activity:** 3.3.1 Natural Regeneration by Seeds, Root Suckering, and/or Coppicing.

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**Priority 1**

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
3.3.1.1	Evaluate and disseminate experiences and practices of farmers and foresters. Output: Documentation of current practices.	X	X								
3.3.1.2	Evaluate and disseminate information on phenology and natural regeneration including coppicing, root suckering, and direct seeding. Output: Documentation of current knowledge.	X	X	X							
3.3.1.3	Establish trials on root suckering and coppicing. Output: Technology.	X	X	X							
<i>Supplementary</i>											
3.3.1.4	Initiate research on phenology and natural regeneration. Output: Technology.	X	X	X	X	X	X	X	X	X	X

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.4 Harvesting and Transportation.

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**Activity:** 3.4.1 Use of Tools and Ergonomics.

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**Priority 3**

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
3.4.1.1	Document and evaluate current practices with reference to tools and their uses. Output: Information.	X	X									
<i>Optimizing</i>												
3.4.1.2	Design and carry out trials on use of tools. Output: New tools and technology.		X	X								
3.4.1.3	Carry out trials for ergonomics with reference to efficient use of tools. Output: Technology.		X	X								

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**Subobjective 3:** *Develop Management Systems for MPTS.*

---

**Goal:** 3.4 Harvesting and Transportation.

---

**Activity:** 3.4.2 Utilization Studies.

---

**Priority 2**

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
3.4.2.1	Review of appropriate utilization aspects.	X	X								
3.4.2.2	Study calorific values of fuelwood, leaves, and twigs. Identify likely storage methods for forage, etc.		X	X	X						
3.4.2.3	Conduct fodder storage trials. Rank species for calorific yield. Output: Calorific yield tables, fodder storage designs, etc.				X	X					
<i>Optimizing</i>											
3.4.2.4	Follow up on 3.4.2.1. Output: Further search activities.		X	X	X	X					

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**Subobjective 3:** *Develop Management Systems for MPTS.*

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**Goal:** 3.5 Marketing and Economics.

---

**Activity:** 3.5.1 Organization, Transportation, and Marketing of Small Scattered Quantities and Products.

**Priority 2**

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
3.5.1.1	Review literature. Survey current farmer outputs, identify control of transport, price structures (and fixing) marketing organizations, market place sale, and demand. Review agricultural experience of crop marketing, including cooperatives. Output: Baseline survey.	X	X	X							
<i>Optimizing</i>											
3.5.1.2	Predict future supplies and demand and type of produce and evaluate farmers' marketing strategy. Output: Guidelines for development of transport and marketing systems more under farmers' control, e.g., cooperatives.		X	X	X						
3.5.1.3	Set up systems and monitor success of systems and their relation to farmers' objectives.						X	X	X	X	X
<i>Supplementary</i>											
3.5.1.4	Set up special buying organization.										X



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**Subobjective 3:** *Develop Management Systems for MPTS.*

---

**Goal:** 3.5 Marketing and Economics.

---

**Activity:** 3.5.2 Economics of On-Farm Production of Trees and Tree Product **Priority 3**

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<hr/>											
<i>Lead</i>											
3.5.2.2	Using information from 3.5.1.1, prepare farm budget models for selected typical farms including expected and actual yields. Output: Farm budget models.	X	X	X							
<i>Optimizing</i>											
3.5.2.3	Evaluate sensitivity of farmers' income to price changes, product mix, variation in yield of different products, variations in (a) own labor demand; (b) employed labor and wage rate. Output: Farm models for project design.	X	X	X							

---

**Subobjective 4:** *Develop Pest Management Systems for Key Pests and Diseases.*

The production of benefits from MPT species is constantly threatened by the possibility of an outbreak of a pest or disease. Some species have been grown successfully for years, even centuries, without economic loss. Others have been quickly subject to major problems when grown as exotics, particularly in pure stands.

There is a need to document the existing knowledge in a computer-based data system that will serve to assist in assessing the significance of a specific pest or disease. When this knowledge is combined with field assessment of such a pest or disease it may then be possible to indicate priorities for the development of an integrated pest management system.

Adequate pest management systems can only be devised once the population dynamics and host relationships of a pest species are known. Derivation and supervision of a suitable pest management system will require the backup of experienced staff in the fields of entomology and pathology.

**Subobjective 4:** *Pest Management Systems for Key Pests and Diseases.*

---

**Goal:** 4.1 Pest Management Systems for Key Pests and Diseases.

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**Activity:** 4.1.1 Biology and Control of Key Pests and Diseases.

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
4.1.1.1	Devise an information retrieval system for up-to-date lists of pests and pathogens and management/control systems. Output: A computer-based data bank.	X	X									
<i>Safeguard</i>												
4.1.1.2	Carry out an appraisal of pest and disease damage by zones to define the problems of pest management in their correct perspective. Output: Recommendation on further research under 4.1.1.3.	X	X									
<i>Optimizing</i>												
4.1.1.3	Develop appropriate sampling techniques and study the population dynamics/host relationships of key pests of MPT species. Output: Basic knowledge on which to build pest management systems.			X	X	X	X	X	X	X	X	X

---

**Subobjective 4:** *Pest Management Systems for Key Pests and Diseases.*

---

**Goal:** 4.1 Pest Management Systems for Key Pests and Diseases.

---

**Activity:** 4.1.1 Biology and Control of Key Pests and Diseases.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Optimizing</i> 4.1.1.4	Develop methods to control pest populations in integrated pest management systems. Output: Recommendations for specific pest management.					X	X	X	X	X	X
<i>Supplementary</i> 4.1.1.5	To train and maintain a cadre of expertise in pest management and extend the systematic knowledge of pests and diseases. Output: Updating of computer-based data bank; retaining expert personnel on pest management in case of major outbreaks.	X	X	X	X	X	X	X	X	X	X

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**Subobjective 4:** *Develop Pest Management Systems for Key Pests and Diseases.*

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**Goal:** 4.2 Fire Protection in Land Use Employing MPT Species

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**Activity:** 4.2.1 Devise Suitable Systems of Rural Fire Prevention and Protection.

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i> 4.2.1.1	Develop fire brigade systems for rural communities. Outputs: Guidelines for institution building.	X	X	X	X	X	X	X	X	X	X
<i>Optimizing</i> 4.2.1.2	Reevaluate the use of early burning techniques for fire control and prevention. Output: Guidelines for implementation and extension.	X	X	X							



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**Subobjective 4:** *Develop Pest Management Systems for Key Pests and Diseases.*

---

**Goal:** 4.3 Animal Protection in Land Use Employing MPT Species.

---

**Activity:** 4.3.1 Systems to Protect MPT Species From Animal Damage.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
Lead 4.3.1.1	Investigate animal repellents and other chemical/poison methods for prevention against and protection from animal damage to MPT crops. Output: Recommendations on prevention and protection measures.	X	X	X	X	X					

---

**Subobjective 5:** *Develop Techniques and Systems for Maintaining and Improving Soil Productivity.*

All production of biomass, whether as leaves, branches, fruits, stems, or roots, depends ultimately on the soil on which a species is grown. Soil productivity is not an indestructible entity; it is fragile and easily destroyed by misuse or overuse, but also amenable to sensible management and cultural practices.

The balance of nutrient inputs and outputs as well as the periodic peaks and troughs in these nutrient balances will determine soil productivity. This nutrient balance is determined by what is lost to the site in harvested material, soil erosion, and leaching on the one hand, and on the other hand what is returned by way of parent material decomposition, aerial deposition, fertilizers, and biological fixation of atmospheric nitrogen. Nitrogen is the only element that can be added by means of biological activity.

The determination of the nutrient balance in a soil system being cropped for forest products is a difficult task, even in monocultural plantations being managed on relatively long rotations. It is doubly difficult with MPT species being harvested regularly for wood, foliage, and fruits and grown in association with other crops. Nevertheless, the true nature of the nutrient balance must be known if soil productivity is to be conserved.

**Subobjective 5:** *Develop Techniques and Systems for Maintaining and Improving Soil Productivity.*

---

**Goal:** 5.1 Studies on the Effects of Using Suitable N-Fixing for Inoculation of MPT Species.

---

**Activity:** 5.1.1 Culture and Inoculation Methods for MPTS with N-Fixing Organisms.

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Subactivity	Description & Outputs	Time—Years											
		1	2	3	4	5	6	7	8	9	+		
<i>Lead</i>													
5.1.1.1	Apply existing technology for the inoculation of N-fixing species with known strains of <i>Rhizobium</i> sp. and actinomycetes. Output: Availability of cultures, improved laboratory facilities, staff training, and instruction manual(s).		X	X									
5.1.1.2	Establish and staff laboratories specifically designed to handle N-fixing inocula. Output: Efficient inocula and inoculation procedures.		X	X									
<i>Safeguard</i>													
5.1.1.3	Review existing technology and evolving research, particularly for <i>Frankia</i> sp., for the inoculation of N-fixing MPT species. Output: Recommendations for modifying technology under 5.1.1.1.			X	X								

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**Subobjective 5:** *Develop Techniques and Systems for Maintaining and Improving Soil Productivity.*

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**Goal:** 5.1 Studies on the Effects of Using Suitable N-Fixing for Inoculation of MPT Species.

---

**Activity:** 5.1.1 Culture and Inoculation Methods for MPTS with N-Fixing Organisms.

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Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Optimizing</i> 5.1.1.4	Develop improved techniques for the culture and inoculation of N-fixing species with known strains of <i>Rhizobium</i> sp. and actinomycetes for use with MPT species. Output: Improved techniques and facilities, staff training.		X	X	X						
<i>Supplementary</i> 5.1.1.5	Select high N-fixing strains of <i>Rhizobium</i> sp. and actinomycetes for MPT species. Output: Progressive introduction of improved cultures.		X	X	X	X	X	X	X	X	X

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**Subobjective 5:** *Develop Techniques and Systems for Maintaining and Improving Soil Productivity.*

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**Goal:** 5.1 Studies on the Effects of Using Suitable N-fixing for Inoculation of MPT Species.

---

**Activity:** 5.1.2 Evaluate the Effects of N-Fixing Species on Soil Productivity.

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Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<hr/>												
<i>Lead</i>												
5.1.2.1	Make a comparative assessment of N-fixing MPT species in pure and mixed stands to identify soil improving systems (see also 5.2.1.2). Output: Recommendations on soil management systems using N-fixing species in looseleaf manual form.	X	X									
<i>Safeguard</i>												
5.1.2.2	Survey and evaluate existing use of N-fixing species outside the region with a view to incorporating and modifying existing technology. Output: Recommendations for modifications under 5.1.2.1.	X	X	X	X							
<i>Optimizing</i>												
5.1.2.3	Conduct field evaluation trials incorporating new or modified techniques for growing N-fixing species to monitor effects on soil N and organic matter. Output: Further recommendations on soil management systems using N-fixing species for incorporation in the manual.			X	X	X	X	X				
<i>Supplementary</i>												
5.1.2.4	Implement long-term trials for a limited range of species at key institutes to study the N-cycle and accumulation of organic matter in soils under various management systems. Output: A comprehensive review of soil management systems using N-fixing species and recommendations on practice in a new manual.	X	X	X	X	X	X	X	X	X	X	X

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**Subobjective 5:** *Develop Techniques and Systems for Maintaining and Improving Soil Productivity.*

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**Goal:** 5.2 Nutrient Cycling and Nutrient Flux.

---

**Activity:** 5.2.1 Nutrient Cycling and Nutrient Flux Under a Range of Management Options.

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
5.2.1.1	Survey existing literature and current research and devise broad guidelines for soil management. Output: A soil management looseleaf manual.	X	X									
5.2.1.2	Establish and staff a laboratory specifically designed to handle soil and plant analyses efficiently and expeditiously to determine nutrient pools and fluxes (see also 5.1.2). Output: Efficient handling of soil and foliage nutrient analyses.	X	X									
<i>Safeguard</i>												
5.2.1.3	Carry out an up-to-date inventory using biomass partitioning and comparative study of the status of soil nutrients in relation to the growth of a few selected MPT species, by countries, to determine the distribution of nutrients. Output: Identify nutrient deficiency problems and make recommendations for fertilizer research.	X	X									
<i>Optimizing</i>												
5.2.1.4	Initiate fertilizer experiments on nutrient deficient areas to determine suitable low input/medium output technology. In the short term, simple experiments are required to indicate the need for fertilization at planting. Particular attention to be given to high density plantings. Output: Recommendations for fertilizer use for incorporation in the manual under 5.2.1.1.	X	X	X	X	X	X	X	X	X	X	X
5.2.1.5	Carry out experiments using variable forage cutting frequencies to determine the effects on growth and the nutrient balance (see 3.1.2.2). Output: Determination of nutrient efficient systems of lopping.	X	X	X	X	X	X	X				



---

**Subobjective 5:** *Develop Techniques and Systems for Maintaining and Improving Soil Productivity.*

---

**Goal:** 5.2 Nutrient Cycling and Nutrient Flux.

---

**Activity:** 5.2.1 Nutrient Cycling and Nutrient Flux Under a Range of Management Options.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Supplementary</i>											
5.2.1.6	Initiate long-term experiments employing a few selected MPT species and management systems on a range of sites and environments to determine more suitable guidelines for soil management. Output: A complete revision of the Soil Management Manual.			X	X	X	X	X	X	X	X

---

**Subobjective 6:** *Determine Social, Economic, and Environmental Aspects.*

The social, economic, and environmental aspects of major forestry programs are significant but often neglected attributes. All too often they are not taken into account at the beginning of a program. Moreover, monitoring, evaluation, and feedback concerning the social, economic, and environmental aspects of a program are usually neglected.

---

**Subobjective 6:** *Determine Social, Economic, and Environmental Aspects.*

---

**Goal:** 6.1 Environmental Impact Analysis (EIA).

---

**Activity:** 6.1.1 Application of Techniques of Environmental Impact Analysis (EIA).

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<hr/>												
<i>Lead</i>												
6.1.1.1	Review appropriateness of existing techniques and develop techniques of EIA and Environmental Impact Statement (EIS) for regional conditions. Output: Technology of EIA and EIS; regional manual.											
<i>Optimizing</i>												
6.1.1.2	Disseminate awareness of EIA as an integral part of MPT projects (e.g., see FAO For. Paper No. 7). Output: Increases awareness.											
<i>Supplementary</i>												
6.1.1.3	Conduct studies in areas subject to extensive forest development to monitor impacts on hydrological regime, soil erosion, desertification, and biological resources. Output: Information on impacts.											

---

**Subobjective 6:** *Determine Social, Economic, and Environmental Aspects.*

---

**Goal:** 6.2 Socioeconomic Study.

---

**Activity:** 6.2.1 Determination of Supply and Demand and Farmers' Perceptions.

---

Subactivity	Description & Outputs
<i>Lead</i>	
6.2.1.1	Examine, evaluate, and disseminate existing information. Output: Brief summary for publication.
6.2.1.2	In coordination with 3.2.5 and 3.5.2 evaluate the most widespread and commonly perceived needs of farmers, including their attitudes to off-farm forestry and social constraints to project implementation; assess those socioeconomic factors that influence land development programs using MPT; and evaluate the socioeconomic impact of MPT projects on the rural population. Output: Regional compilations; guidelines to further research.
6.2.1.3	Conduct economic analysis including financial and social return. Output: Economic evaluation of projects.
6.2.1.4	Land use planning: analyze the consequences of projects including policy implications and the integration of physical, economic, and social consequences. Output: Improved planning.
6.2.1.5	Set up teams for farm systems diagnoses, including sociological, economic, and technical specialists. Output: Regular surveys for monitoring and evaluation.

---

**Subobjective 6:** *Determine Social, Economic, and Environmental Aspects.*

---

**Goal:** 6.2 Socioeconomic Studies.

---

**Activity:** 6.2.2 Monitoring and Evaluation.

---

Subactivity	Description & Outputs
<i>Lead</i> 6.2.2.1	In coordination with all other activities, survey physical achievements and economic and social effects of ongoing programs through independent institutions and analyze projected impacts of research results if successful and applied to projects. Output: Progress reports on monitoring, evaluation summaries, and feedback to improved design.
<i>Optimizing</i> 6.2.2.2	Develop or adapt effective recording systems paying particular attention to impacts on landless persons. Output: Recording system.
<i>Supplementary</i> 6.2.2.3	Examine remote sensing as quick check on physical achievements, location of trees, etc. Output: Monitoring tool.



---

**Subobjective 7:** *Provide Institutional Support and Common Services.*

Throughout research and development of MPTS there are common institutional problems. Solutions to these problems are considered in this subobjective.

No program can exist or run efficiently without adequately trained staff at all levels and training includes formal and informal courses at universities, institutions and in the field. Particular attention must be paid to extension of research results to line managers and operational techniques to local landowners.

Fundamental to all effective research and development is the availability of relevant information including published material, unpublished research results, and anecdotal information. Data bases must be created, maintained, and used with widespread dissemination including translation into other languages. IUFRO itself may play an important role.

The sociological, economic, and environmental effects of all research and development activities should be evaluated; there is clearly a need for coordination/harmonization of all activities within all five major objectives.

**Subobjective 7:** *Provide Institutional Support and Common Services.*

---

**Goal:** 7.1 Education, Training, and Extension.

---

**Activity:** 7.1.1 Professional Education and Training.

---

Subactivity	Description & Outputs	Time—Years										
		1	2	3	4	5	6	7	8	9	+	
<i>Lead</i>												
7.1.1.1	Review labor requirements for whole program and select and train staff in appropriate university courses. Output: Trained staff.	X	X	X	X	X	X	X	X	X		
7.1.1.2	Select appropriate staff and train by in-service training courses (e.g., research methods, research management, agroforestry). Output: Trained staff.	X	X	X	X	X	X	X	X	X		
7.1.1.3	Develop and implement facilities for on-the-job training including staff exchanges by twinning and network arrangements.	X	X	X	X	X	X	X	X	X		
<i>Safeguard</i>												
7.1.1.4	Establish new courses if needed. Output: Trained staff.	X	X	X	X	X	X	X	X	X		

---

**Subobjective 7:** *Provide Institutional Support and Common Services.*

---

**Goal:** 7.1 Education, Training, and Extension.

---

**Activity:** 7.1.2 Technical Training.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
7.1.2.1	Develop inservice training courses; select and train staff. Output: Trained staff.	X	X	X	X	X	X	X	X	X	
<i>Optimizing</i>											
7.1.2.2	Develop field handbooks and manuals. Output: Availability of operational techniques.	X	X	X	X	X	X	X	X	X	

---

**Subobjective 7:** *Provide Institutional Support and Common Services.*

---

**Goal:** 7.1 Education, Training, and Extension.

---

**Activity:** 7.1.3 Extension.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
7.1.3.1	Develop inservice training courses where necessary for subject matter specialists. Output: Trained staff.	X	X	X	X	X	X	X	X	X	X
7.1.3.2	Develop radio and printed extension teaching material and demonstration plots. Output: Material and demonstration.	X	X	X	X	X	X	X	X	X	X
7.1.3.3	Check and update if necessary the system for implementing research results. Output: Technical orders for line staff concerned with implementation.	X	X	X	X	X	X	X	X	X	X
<i>Optimizing</i>											
7.1.3.4	Preparation of manuals and notes for circulation within network. Output: Material for current awareness of research results and extension.	X	X	X	X	X	X	X	X	X	X

---

**Subobjective 7:** *Provide Institutional Support and Common Services.*

---

**Goal:** 7.2 Information Provision.

---

**Activity:** 7.2.1 Utilize Existing Information.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i> 7.2.1.1	Search, evaluate, summarize, and publish research trials and files. Output: Information in accessible form.	X	X	X	X	X	X	X	X	X	X
<i>Supplementary</i> 7.2.1.2	Survey or update anecdotal information on multiple uses. Output: Information.	X	X	X	X	X	X	X	X	X	X
7.2.1.3	Develop uniform assessment and recording procedures and network publication systems. Output: Information (comparable).	X	X	X	X	X	X	X	X	X	X

---

**Subobjective 7:** *Provide Institutional Support and Common Services.*

---

**Goal:** 7.2 Information Provision.

---

**Activity:** 7.2.2 Increase Awareness of Published Information.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
7.2.2.1	Increase supply of literature to operational and research staff. Output: Increased awareness.		X	X	X	X	X	X	X	X	
7.2.2.2	Increase supply of abstract and selective current awareness services. Output: Increased awareness.		X	X	X	X	X	X	X	X	
7.2.2.3	Strengthen translation service. Output: Increased awareness.		X	X	X	X	X	X	X	X	



---

**Subobjective 7:** *Provide Institutional Support and Common Services.*

---

**Goal:** 7.2 Information Provision.

---

**Activity:** 7.2.3 Create and Maintain Data Bases.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
7.2.3.1	Assess and provide hardware and develop compatible software for data bases (creation, updating, and assessing provenance trials results, conservation activities, etc.). Output: Secure repository of data.	X	X	X	X	X	X	X	X	X	X
7.2.3.2	Provide for servicing of enquiries and supply of analyses, interpretation, and hard copy. Output: Information.	X	X	X	X	X	X	X	X	X	X
7.2.3.3	Facilitate input and retrieval of information from existing data bases. Output: Improved information transfer.	X	X	X	X	X	X	X	X	X	X

---

**Subobjective 7:** *Provide Institutional Support and Common Services.*

---

**Goal:** 7.2 Information Provision.

---

**Activity:** 7.2.4 Involve IUFRO Research Groups.

---

Subactivity	Description & Outputs	Time—Years									
		1	2	3	4	5	6	7	8	9	+
<i>Lead</i>											
7.2.4.1	Provide for attendance of staff from the region at IUFRO meetings. Output: Current awareness, coordination.	X	X	X	X	X	X	X	X	X	
<i>Supplementary</i>											
7.2.4.2	Disseminate lists of IUFRO Working Parties and Project Groups. Output: Increased networking and awareness.	X	X	X	X	X	X	X	X	X	
7.2.4.3	Provide for publication of IUFRO meeting publications, monographs, network publications, etc. Output: Information.	X	X	X	X	X	X	X	X	X	

#### Appendix IV: Checklist of Species vs. Activities by Zone as Prepared by the Workshop Participants

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This appendix is a summary of the detailed species by subactivities checklist matrix prepared by each country at the workshop. In its original form the matrix included the following values: 1=need for research; 2=an interest in research; and 3=no interest. The latter two categories were not used in the development of the summary matrices. Therefore, figures in any column or row represent the total number of countries showing a need for research in a particular species and/or activity. Also for consistency only activities were used, not subactivities, as some groups chose to reduce the detail in their responses.

The main use of the data presented in the appendix is to show the priority rankings of the MPTS and the research activity. See appendices V, VI, and VII.

The countries represented in the exercise for each zone are listed below.

##### **Moist/Wet Zone**

Bangladesh  
China  
India  
Indonesia  
Malaysia  
Nepal  
Papua New Guinea  
Philippines  
Sri Lanka  
Taiwan  
Thailand

##### **Arid/Semiarid Zone**

India  
Pakistan  
Philippines

##### **Mountainous Zone**

India  
Malaysia  
Nepal  
Pakistan  
Philippines

---

### Moist/Wet Tree Species

MW-1	<i>Acacia auriculiformis</i>
MW-2	<i>A. mangium</i>
MW-3	<i>Albizia</i> spp.
MW-4	Bamboos
MW-5	<i>Casuarina equisetifolia</i>
MW-6	<i>Dalbergia sissoo</i>
MW-7	<i>Eucalyptus</i> spp.
MW-8	<i>Leucaena leucocephala</i>
MW-9	<i>Azadirachta indica</i>
MW-10	<i>Sesbania</i> spp.
MW-11	<i>Artocarpus</i> spp.
MW-12	<i>Gliricidia sepium</i>
MW-13	Secondary species

# Priority Species and Activities

Zone: Moist/Wet

Country: All

Activity	Species													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1.1.1	8	7	7	7	4	2	5	5	2	1	1	1		50
1.1.2	7	7	5	6	5	3	6	6	2	2	2	2		53
1.2.1	8	8	5	5	4	3	6	6	2	1	2	1		51
1.2.2	5	5	3	6	2	3	5	4	2	1	1	1		38
1.2.3	8	9	5	6	5	3	5	6	2	1	1	1		52
1.3.1	7	6	4	7	3	2	7	6	2	2	2	2		50
1.3.2	2	2	3	6	2	2	4	3	1	2	2	2		31
2.1.1	8	10	6	6	3	3	6	7	2	2	1	1		55
2.2.1	5	6	3	5	3	2	5	5	1	1	1	1		38
2.3.1	6	3	4	4	2	2	5	3	1	1	1	1		33
2.4.1	5	6	4	4	3	3	5	6	1	1				38
3.1.1	7	7	5	5	4	3	8	8	2	2		1		52
3.1.2	6	7	3	4	3	1	6	6		1	2	1		40
3.1.3	6	6	3	6	3	2	6	6	2	2	2	1		45
3.1.4	3	4	2	3	2	2	6	6	1	1	2	1		33
3.2.1	6	5	5	5	4	2	6	6	1	2	2	1		45
3.2.2	2	2	2	3	2	2	4	5	1	3	2	1		29
3.2.3	1	2	1	2	1	2	4	2						15
3.2.4	5	3	3	5	4	2	5	3	2	1	1	1		35
3.2.5	2	2	2	2	1	1	3	3	1	1	2	1		21
3.2.6	2	2	1	3	2	1	3	2	1	1	1	1		20
3.3.1	4	4	4	5	1	2	5	4	1	1	2	1		34
3.4.1	1		1	2		1	2	1						8
3.4.2	5	5	2	4	3	2	5	5	2	1	1	1		36
3.5.1	1	1	2	3		1	2	4	1					15
3.5.2	1	1	1	3	1	1	3	4		1	2	1		19
4.1.1	4	4	6	6	3	2	4	3	2	1	1	1	1	38
4.2.1	1	1	1	3	2	2	3	3	1	1	1	1	1	21
4.3.1	1	1	1	2	1	2	2	3	1	1	1	1	1	18
5.1.1	6	5	5	4	3	3	3	6	2	2	2	1	1	43
5.1.2	5	6	6	3	4	3	3	4	2	2	2	2	1	43
5.2.1	3	3	4	5	2	3	2	2	1	2	1	2	1	31
<b>Total</b>	141	140	109	140	82	68	144	143	42	41	41	33	6	



---

### Arid/Semiarid Tree Species

AS—1	<i>Acacia nilotica/arabica</i>
AS—2	<i>A. senegal</i>
AS—3	<i>A. tortilis</i>
AS—4	<i>Eucalyptus camuldulensis</i>
AS—5	<i>E. microtheca</i>
AS—6	<i>Morus</i> spp.
AS—7	<i>Prosopis cineraria/spicigera</i>
AS—8	<i>P. juliflora</i>
AS—9	<i>Azadirachta indica</i>
AS—10	Bamboos
AS—11	<i>Dalbergia sissoo</i>
AS—12	<i>Populus</i> spp.
AS—13	<i>Tamariz aphylla</i>
AS—14	Secondary species—too few notations to include in tables on priorities.

Priority Species and Activities

Zone: Arid/Semiarid

Country: All

Activity	Species													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1.1.1	2		2	1			2			2		2		11
1.1.2	1	2		2	1	1		2		1			2	12
1.2.1	2	1	2	2	1	2	2	1	1	2	2	2	1	21
1.2.2	1	1		1	1		1		1	2	2	2		12
1.2.3	1	1	1	1	1	1	1	1	1	1	1	1	1	13
1.3.1														
1.3.2	1	1				1	1	1	1	1	1	1		9
2.1.1				2	2	1			1	2	2	2		12
2.2.1														
2.3.1														
2.4.1	1		1	1			1		1	1				6
3.1.1	2			2	1		1		1	2	1	1	1	12
3.1.2	2			2	1	1	2	1	1		1	1		12
3.1.3	2		1	2	2	1		1	1	2	1	1		14
3.1.4				3								2		5
3.2.1	2			3		2	2	1	2	2	2	2	2	20
3.2.2	2			1	1	1	1	1	1	1	1	2		12
3.2.3														
3.2.4	2			2	1	2		1	1	2	2	1	2	16
3.2.5														
3.2.6	2			3	1	2		1	1	2	2	1		15
3.3.1														
3.4.1														
3.4.2	1	1	1	1	1	1	1	1	1	1	1	1	1	13
3.5.1	Data from the Philippines are included in this table; therefore the numbers may differ from other tables													
3.5.2														
4.1.1	1											2		3
4.2.1														
4.3.1						2						2		4
5.1.1	2	2	2				2	2				2		12
5.1.2	2	2	2				2	2				2		12
5.2.1	2	2	2	2	2	2	2	2	2	2	2	2	2	26
<b>Total</b>	31	13	14	31	16	20	21	18	17	26	21	32	12	

---

### Mountainous Zone Species

MZ—1	<i>Alnus</i> spp. ( <i>A. nepalensis</i> , <i>nitida</i> , <i>rubra</i> , <i>japonica</i> )
MZ—2	<i>Celtis australis</i>
MZ—3	<i>Prunus</i> spp. ( <i>P. cerasoides</i> , <i>puddum</i> , <i>amygdalis</i> )
MZ—4	<i>Grewia oppositifolia</i>
MZ—5	<i>Populus</i> spp. ( <i>P. ciliata</i> , <i>gamble</i> , <i>alba</i> , <i>nigra</i> , <i>deltoides</i> , <i>euramericana</i> hybrids)
MZ—6	<i>Robinia pseudoacacia</i>
MZ—7	<i>Salix</i> spp. ( <i>S. alba</i> , <i>babylonica</i> , <i>tetrasperma</i> )
MZ—8	Bamboos ( <i>Dendrocalamus strictus</i> , <i>D. sikkimensis</i> , <i>D. kookerii</i> , <i>D. hamiltonii</i> , <i>Bambusa vulgaris</i> , <i>B. balcoa</i> , <i>B. tulda</i> , <i>B. nutans</i> , <i>Melocanna baccifera</i> )
MZ—9	<i>Pinus</i> spp. ( <i>P. kesiya</i> , <i>merkusii</i> , <i>roxburghii</i> , <i>wallichiana</i> , <i>gerardiana</i> )
MZ—10	Test species

# Priority Species and Activities

Zone: Mountainous

Country: All

Activity	Species													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1.1.1	1	1	1	1	2	3	2	3	3	4				21
1.1.2	4	2	2	2	2	3	3	3	4	3				28
1.2.1	3	3	2	3	2	2	2	3	4					24
1.2.2	1	1	1	1	2	2	1	2	1					12
1.2.3	4	3	2	3	2	3	2	4	4	2				29
1.3.1	2	2	2	2	2	2	1	1	2					16
1.3.2				1					1					2
2.1.1	4	3	3	3	3	3	3	4	4					30
2.2.1	2	2	2	2	2	2	2	3	3					20
2.3.1	3	3	3	3	3	2	3	4	4					28
2.4.1	4	3	3	3	3	3	3	4	4	1				31
3.1.1	4	2	2	2	2	2	2	3	4					23
3.1.2	4	3	3	3	2	2	2	3	2					24
3.1.3	2	2	2	3	2	2	2	4	3					22
3.1.4	1	1	1	1	1	1	1	1	1					9
3.2.1	2	1	1	1	2	1	1	2	3					14
3.2.2	2	2	1	3	1	1	1	3	2					16
3.2.3								1	1					2
3.2.4	1							1	1					3
3.2.5	2	1	1	1	1	1	1	2	2					12
3.2.6	2	2	2	2	2	2	2	2	2					18
3.3.1	1			1	1	2	1	4	3	1				14
3.4.1	1	1	1	1	1	1	2	3	3					14
3.4.2	3	2	2	3	2	2	2	4	3					23
3.5.1	2					1	1	2	2					8
3.5.2	2	1	1	1	2	1	2	2	3					15
4.1.1	1	1	1	1	1	1	1	2	3					12
4.2.1														
4.3.1		1	1	1		1								4
5.1.1	1	1	1	1	1	2	1	1	1					10
5.1.2	2	1	1	1	1	2	1	1	1					11
5.2.1	2	2	2	2	2	3	2	3	3					21
<b>Total</b>	63	47	44	52	47	53	47	75	77	11				

## Appendix V. List of Priority Species by Moist/Wet, Arid/Semiarid, and Mountainous Zones

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### Moist/Wet Zone

1. *Eucalyptus* spp.
2. Bamboo species
3. *Leucaena leucocephala*
4. *Acacia mangium*
5. *Acacia auriculiformis*
6. *Albizia* spp.
7. *Casuarina* spp.
8. *Dalbergia sissoo*
9. *Azadirachta indica*
10. *Gmelina arborea*
11. Rattan species
12. *Sesbania* spp.
13. *Artocarpus* spp.
14. *Gliricidia sepium*

### Arid/Semiarid Zone

1. *Acacia nilotica*
2. *Populus* spp.
3. *Eucalyptus camaldulensis*
4. Bamboo species
5. *Prosopis cineraria*
6. *Morus alba*
7. *Dalbergia sissoo*
8. *Prosopis juliflora* (*P. chilensis*)
10. *Eucalyptus microtheca*
11. *Acacia tortilis*
12. *Acacia senegal*
13. *Tamarix aphylla*

### Mountainous Zone

1. *Pinus* spp.
2. Bamboo species
3. *Alnus* spp.
4. *Robinia pseudoacacia*
5. *Populus* spp.
6. *Salix* spp.
7. *Grewia oppositifolia*
8. *Celtis australis*
9. *Prunus* spp.

**Appendix VI. Five Most Important Activities for Priority Species by Moist/Wet, Arid/Semiarid, and Mountainous Zones**

**Moist/Wet Zone**

Species	Activity
1. <i>Eucalyptus camaldulensis</i>	3.1.1, 3.1.2, 3.1.3—Spacing, Thinning, & Rotation; Foliage Manipulating; Tree Species Mixtures 1.2.1—Tree Breeding 1.1.1—Exploration & Evaluation 1.2.2—Development of Vegetative Propagation 4.1.1—Pest Biology & Control
2. <i>Acacia mangium</i>	3.1.1, 3.1.2, 3.1.3—Spacing, Thinning, & Rotation; Foliage Manipulating; Tree Species Mixtures 1.2.1—Tree Breeding 2.1.1—Improve Nursery Stock Production 1.2.2—Vegetative Propagation 5.1.1, 5.1.2—Culture & Inoculation Methods (N-Fixing org.); Effects on Soil Productivity
3. <i>Leucaena leucocephala</i>	3.1.1, 3.1.2, 3.1.3—Spacing, Thinning, & Rotation; Foliage Manipulating; Tree Species Mixtures 1.2.1—Tree Breeding 3.2.1, 3.2.5—Tree/Crop Interface; Land Use Problem Diagnosis 2.1.1—Improve Nursery Stock Production 1.2.2—Vegetative Propagation
4. <i>Acacia auriculiformis</i>	3.1.1, 3.1.2, 3.1.3—Spacing, Thinning, & Rotation; Foliage Manipulating; Tree Species Mixtures 1.2.1—Tree Breeding 2.1.1—Improve Nursery Stock Production 1.2.2—Vegetative Propagation 5.1.1, 5.1.2—Culture & Inoculation Methods (N-Fixing org.); Effects on Soil Productivity
5. Bamboos	1.2.2—Vegetative Propagation 3.1.1, 3.1.2, 3.1.3—Spacing, Thinning, & Rotation; Foliage Manipulating; Tree Species Mixtures 1.2.1—Tree Breeding 2.1.1—Improve Nursery Stock Production 4.1.1—Pest Biology & Control



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## Arid/Semiarid Zone

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Species	Activity
1. <i>Eucalyptus camaldulensis</i>	1.2.2—Vegetative Propagation 3.1.4—Water Consumption 3.2.1—Tree/Crop Interface 1.2.1—Tree Breeding 3.1.1—Spacing, Thinning, & Rotation
2. <i>Populus</i> spp.	1.2.1—Tree Breeding 3.2.1—Tree/Crop Interface 4.1.1—Pest Biology & Control 3.1.4—Water Consumption
3. Bamboos	1.2.1—Tree Breeding 1.2.2—Vegetative Propagation 3.2.4—Shelterbelts & Windbreaks 3.4.2—Utilization 3.2.1—Tree/Crop Interface
4. <i>Acacia nilotica</i>	3.1.1—Spacing, Thinning, & Rotation 3.1.2—Foliage Manipulation 3.2.4—Shelterbelts & Windbreaks 3.2.1—Tree/Crop Interface 3.1.3—Tree Species Mixtures
5. <i>Prosopis cineraria</i>	3.2.1—Tree/Crop Interface 1.1.1—Exploration 1.1.2—Evaluation 1.2.1—Tree Breeding 3.1.2—Foliage Manipulation

## Mountainous Zone

Species	Activity
1. <i>Pinus</i> spp.	1.1.2—Evaluation 1.2.1—Tree Breeding 1.2.3—Seed Collection, Storage, & Testing 2.1.1—Improve Nursery Stock Production 3.1.1—Spacing, Thinning, & Rotation
2. Bamboos	1.1.2—Evaluation 1.2.1—Tree Breeding 1.2.3—Seed Collection, Storage, & Testing 2.1.1—Improve Nursery Stock Production 2.4.1—Technique Development (Establishment & Tending)
3. <i>Alnus</i> spp.	1.1.2—Evaluation 1.2.1—Tree Breeding 2.1.1—Improve Nursery Stock Production 5.1.1, 5.1.2—Culture & Inoculation Methods (N-Fixing org.); Effects on Soil Productivity
4. <i>Robinia pseudoacacia</i>	1.1.2—Evaluation 1.2.1—Tree Breeding 1.2.3—Seed Collection, Storage, & Testing 2.4.1—Technique Development (Establishment & Tending) 3.1.2—Foliage Manipulation
5. <i>Populus</i> spp.	1.1.2—Evaluation 1.2.1—Tree Breeding 3.2.1—Tree/Crop Interface 3.2.6—Irrigated Farming Systems 4.1.1—Pest Biology & Control
6. <i>Salix</i> spp.	1.1.2—Evaluation 1.2.1—Tree Breeding 2.4.1—Technique Development (Establishment & Tending) 3.1.2—Foliage Manipulation 3.1.1—Spacing, Thinning, & Rotation

## **Appendix VII. Five Most Important Species for Top Priority Activities by Moist/Wet, Arid/Semiarid, and Mountainous Zones**

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The frequency of the five most important activities for the five top species was analyzed by zones. Although these data reflect the greatest needs, many less frequently noted activities are essential for success with a given species or in a single zone.

In the Moist/Wet Zone, activities 1.2.1 (Tree Breeding), 3.1.1 (Spacing, Thinning, & Rotation), 3.1.2 (Foliage Manipulation) and 3.1.3 (Tree Species Mixtures) were noted with equal frequency. These activities were followed closely by 1.2.2 (Vegetative Propagation) and 2.1.1 (Improve Nursery Stock Production) in second position. Other activities were noted with similar frequencies.

In the Mountainous Zone, activity 1.1.2 (Evaluation) ranked first followed by 1.2.3 (Tree Breeding). Activity 2.4.1 (Technique Development—Establishment & Tending) ranked third. Activities 1.2.3 (Seed Collection & Storage) and 2.1.1 (Improve Nursery Stock Production) also ranked high.

For all three zones, activity 1.2.1 (Tree Breeding) was noted most frequently, followed by 1.1.2 (Evaluation), 3.1.1 (Spacing, Thinning, & Rotation), and 3.1.2 (Foliage Manipulation). Activities 1.2.2 (Vegetative Propagation), 2.1.1 (Improve Nursery Stock Production) and 3.2.1 (Tree/Crop Interface) ranked third.

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### Five Most Important Species for Top Priority Activities—Moist/Wet Zone

Activity	Species
1. 2.1.1—Improvement of Nursery Stock Production	<i>Acacia mangium</i> <i>Leucaena leucocephala</i> Bamboos <i>A. auriculiformis</i> <i>Eucalyptus</i> spp.
2. 3.1.1—Spacing, Thinning, and Rotation	<i>Eucalyptus</i> spp. <i>leucocephala</i> <i>A. mangium</i> <i>A. auriculiformis</i> <i>Albizia</i> spp.
3. 1.2.3—Seed Collection, Storage, and Testing	<i>A. mangium</i> <i>A. auriculiformis</i> Bamboos <i>Eucalyptus</i> spp. <i>L. leucocephala</i>
4. 1.1.2—Evaluation	Bamboos <i>A. auriculiformis</i> <i>Eucalyptus</i> spp. <i>L. leucocephala</i> <i>A. mangium</i>
5. 1.2.1—Tree Breeding	<i>A. auriculiformis</i> <i>A. mangium</i> <i>Eucalyptus</i> spp. <i>L. leucocephala</i> Bamboos
6. 1.3.1— <i>Ex situ</i> Conservation	

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### Five Most Important Species for Top Priority Activities—Arid/Semiarid Zone

Activity	Species
1. 5.2.1—Nutrient Cycling and Nutrient Flux	<i>Acacia nilotica</i> <i>Populus</i> spp. <i>Eucalyptus camaldulensis</i> Bamboos <i>Prosopis cineraria</i>
2. 1.2.1—Tree Breeding	<i>A. nilotica</i> <i>Populus</i> spp. <i>E. camaldulensis</i> Bamboos <i>P. cineraria</i>
3. 3.2.1—Tree/Crop Interface	<i>A. nilotica</i> <i>Populus</i> spp. <i>E. camaldulensis</i> Bamboos <i>P. cineraria</i>
4. 3.2.4—Shelterbelts & Windbreaks	<i>A. nilotica</i> <i>E. camaldulensis</i> Bamboos <i>Morus alba</i> <i>Dalbergia sissoo</i>
5. 3.2.6—Irrigated Farming Systems	<i>E. camaldulensis</i> Bamboos <i>A. nilotica</i> <i>Dalbergia sissoo</i> <i>Morus</i> spp.
6. 3.1.3—Tree Species Mixture	

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### Five Most Important Species for Top Priority Activities—Mountainous Zone

Activity	Species
1. 2.1.1—Improvement of Nursery Production Stock	<i>Alnus</i> spp. Bamboos <i>Pinus</i> spp. <i>Robinia pseudoacacia</i> <i>Populus</i> spp. & <i>Salix</i> spp.
2. 2.4.1—Establishment and Early Tending—Techniques	Bamboos <i>Pinus</i> spp. <i>Alnus</i> spp. <i>R. pseudoacacia</i> <i>Populus</i> spp. & <i>Salix</i> spp.
3. 1.2.3—Seed Collection, Storage and Testing	<i>Pinus</i> spp. Bamboos <i>Alnus</i> spp. <i>Celtis australis</i> <i>Grewia oppositifolia</i>
4. 2.3.1—Site Preparation Techniques	<i>Populus</i> spp. <i>Pinus</i> spp. Bamboos <i>Alnus</i> spp. <i>Salix</i> spp.
5. 1.1.2—Evaluation	<i>Alnus</i> spp. <i>Salix</i> spp. & <i>Populus</i> spp. Bamboos <i>Pinus</i> spp. <i>R. pseudoacacia</i>
6. 1.2.1—Tree Breeding	



The participants developed proposed country/institutional networks for the coleader major species considered. A lead country, and often a coleader, was named along with participating countries having interest in the species. Lead institutions and participating institutions were noted. (The codes for the institutional numbers are attached.) A key feature of the network was to name participating international agencies, especially those most likely to provide external aid and a principal source of financial aid. This listing of participating countries, institutions, and international agencies is not intended to be all inclusive; others may wish to participate.

## Proposed Species Networks

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Network Species	Leader	Coleader(s)	Participating Countries	Lead Institution	Participating Institutions	Participating International Agencies	Most Likely Source of External Funding	Aid For Supporting Regional Network Activities
1. <i>Acacia</i> sp. (a) <i>A. nilotica</i> (b) <i>A. auriculiformis</i> (c) <i>A. senegal</i> (d) <i>A. tortilis</i> (e) <i>A. mangium</i>	India	Malaysia	Indonesia(e + b) Thailand(e + b) Philippines(e + b) Taiwan(b + e) Bangladesh(a + b + e) PNG(b + e) Nepal(b) Sri Lanka(s + e) Pakistan(a + e + d) China(b + e)	3  7	1,2,4,6, 8,9,10, 11,12,13, 14,16,18,19 20,21	UNDP ODA ICRAF CSIRO GTZ E-W Center FAO	GTZ IDRC USAID UNDP ODA(India) IBRD World Bank	USAID
2. Bamboo	Bangladesh	China (Utilization) Thailand (Harvesting & Seed)	All countries except PNG	1,2, 21	All except 5 & 13	IDRC ODA FAO	IDRC ODA	IDRC USAID
3. (a) <i>Albizia</i> & (b) <i>Leucaena</i>	Philippines	Taiwan ( <i>Leucaena</i> )	<i>Leucaena</i> All countries U. of Hawaii <i>Albizia</i> India Bangladesh Nepal Malaysia China Taiwan Pakistan PNG Sri Lanka	15(a) 14(b) 19(b)	<i>Leucaena</i> All except 17, 8,9,10 <i>Albizia</i> 1,2,3, 7,8,10, 11,12,13, 16,18	ODA (CIH) GTZ ICRAF East-West Center FAO	GTZ(Malaysia) USAID World Bank	USAID
4. <i>Eucalyptus</i> spp. <i>E. camaldulensis</i> <i>E. deglupta</i> <i>E. microtheca</i>	India	Indonesia <i>E. deglupta</i> <i>E.urophylla</i>	All countries	3 6 12	All	UNDP USAID ODA FAO	World Bank	
5. (a) <i>Dalbergia</i> sissoo, (b) <i>Morus alba</i> (c) <i>Populus</i> spp.	Pakistan		Bangladesh(a) Nepal India Indonesia(b) China(c) Sri Lanka(b)	12	1,2,3,6, 18,22	GTZ FAO ODA(Nepal)	GTZ(China) USAID	USAID World Bank

6. <i>Azadirachta</i> ( <i>Melia</i> ) spp.	Thailand		India Bangladesh Nepal Pakistan Philippines Malaysia & Taiwan Sri Lanka Indonesia	21	1,3,6,7, 8,11,12,14,15 18,19,20	IDRC FAO ODA(Nepal)	IDRC World Bank	IDRC USAID
7. <i>Rattan</i>	Malaysia	Philippines	Indonesia Thailand Bangladesh India Taiwan PNG Sri Lanka China Pakistan	7 14-Co.	1,2,3,4, 5,6,8,9, 10,12,13, 15,17,18 19,20,21	IDRC FAO	IDRC World Bank	IDRC USAID
8. <i>Prosopis cineraria</i>	India		Pakistan China	3	2,12, 22	UNDP USAID ODA ICRAF FAO	IDRC World Bank	USAID
9. <i>Salix</i> spp. and <i>Robinia pseudo-</i> <i>cacia</i>	India		Nepal China Pakistan	3	2,11,12, 22	GTZ FAO	GTZ(China) World Bank	USAID
10.(a) <i>Alnus</i> <i>nepalensis</i>  (b) <i>Grewia</i> <i>oppositifolia</i>	Nepal		Pakistan China India Philippines(a)	11	2,3,12, 14,16,22	GTZ FAO ICRAF ODA(Nepal)	GTZ(Pakistan) World Bank ODA(Nepal)	USAID

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### Participating Institutions

<u>Code</u>	<u>Address</u>
1.	Forest Research Institute Chittagong, Bangladesh
2.	Tropical Forest Research Institute Canton, Peoples Republic of China
3.	Forest Research Institute & Colleges P.O. New Forest Dehra Dun, India
4.	Kerala Forest Research Institute Peechi 680 653 Kerala, India
5.	Forest Products Research & Development Centre P.O. Box 84 Bogor, Indonesia
6.	Forest Research & Development Centre (FRDC) P.O. Box 66 Bogor, Indonesia
7.	Forest Research Institute Kepong, Selangor, Malaysia
8.	Forest Research Centre P.O. Box 1407 Sandakan, Sabah, Malaysia
9.	Faculty of Forestry Malaysia Agricultural University, Serdang, Selangor, Malaysia
10.	Forest Research Branch Forest Department Kuching, Malaysia
11.	Department of Forest Babar Mahal, Kathmandu, Nepal
12.	Pakistan Forest Institute Peshawar, Pakistan

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<u>Code</u>	<u>Address</u>
13.	Forest Research Division Department of Primary Industry Forest Management Research Branch P.O. Box 5055 Boroko, Papua New Guinea
14.	Forest Research Institute (FORI) College, Laguna, Philippines
15.	College of Forestry University of the Philippines at Los Banos P.O. Box 434, College, Laguna, Philippines
16.	Bureau of Forest Development Dillman, Quezon City Philippines
17.	Isabela State University Philippines
18.	Forest Department Research Branch P.O. Box 509 Colombo 2, Sri Lanka
19.	Forest Research Institute Taipei, Taiwan
20.	Royal Forest Department Bangkok, Thailand
21.	Faculty of Forestry Kastesart University Bangkok, Thailand
22.	Chinese Academy of Forestry Beidisa, PR China

## Appendix IX: Research Topics with Potential to Become the Basis for Further Network Development

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### 1. Soil Productivity

Application of existing research knowledge to soil and site improvement particularly of degraded agricultural or forest wasteland areas. Comparative assessment of N-fixing MPT species in pure and mixed stands. Soil improvement systems by application of existing technology for the inoculation of N-fixing species with known strains of *Rhizobium* spp. and actinomycetes, progressive introduction of improved cultures. Fertilizer experiments in nutrient deficient areas to determine soil and low input/medium input technology. Systematic trials on a limited range of species to study the N and other nutrient cycling and accumulation of organic matter in soils under various management systems particularly close espacement, short rotation maximum biomass production forestry.

Field scale research on establishment methods that have the potential to produce quick results and high fuelwood fodder output at low cost, for example, via direct sowing, dense espacement, and short rotations (combine with N cycle/soil nutrient/fertilizer experiments above).

### 2. Tree Breeding

Species selection and provenance trials of fast growing MPTS.

Identification, demarcation, and collection of seed from superior stands, isolated groups, and/or single trees in order to ensure supplies of proven seed.

Studies of methods for seed collection, temporary storage transport, extraction, and drying.

Creation of clonal and/or seedling orchards of selected MPTS in order to ensure supplies of genetically improved seed.

Development of vegetative propagation methods for selected MPTS particularly via rooted cuttings in order to secure early supplies of improved clonal material.

Lay out of clonal tests of vegetatively propagated planting material.

### 3. Nursery and Establishment Techniques

Nursery and establishment techniques to determine the cheapest, most reliable, and quickest way to ensure successful survival and rapid acceleration of current afforestation rates, for example, direct sowing techniques (where they can be used), use of direct transplant techniques (the "basket" method of raising seedlings), and options for reducing the cost of containers.

### 4. Pests and Diseases

Systematic mycological and entomological research into pests and diseases. Research into animal repellents for protection of MPTS.



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## **5. Sociological Research**

Sociological research to determine farmers' and the local community's perceptions of the usefulness of trees, their preferences over choice of species and to examine the most likely modes of planting and land tenure arrangements, for example, planting of boundary trees, intercropping, block planting on privately owned land and in community owned wood lots, that would most likely result in a positive people response. Research into how to involve the landless in social forestry programs and to ensure rapid acceleration of current rates of afforestation.

## **6. Economic Research/Extension Systems/Monitoring and Evaluation**

Economic research into the cost/benefit implications of all the above research techniques to ensure that before embarking on research programs there is likely to be a reasonable prospect of a positive and significant benefit. Economic research into cash crop tree farming systems that are likely to maximize small farmer incomes. Economic studies of optimal espacement and rotation length of intensive biomass (particularly energy plantation) forestry, economic research into the cost/benefit implication of large scale irrigated forestry.

Extension oriented research into optimal approaches to forestry extension including use of the training and visits (T&V) system so as to ensure that research results and technologies are rapidly disseminated and taken up by small farmers and local communities. Research into optimal and least cost ways for monitoring and evaluation of the application of the research technologies to assess how they performed in practice to test farmers' response and to ensure that benefits reach the poorer sections of the community.

## **7. Management, Harvesting, and Marketing**

Research into pollarding, pruning, lopping, coppicing, and hedgerow management systems that will ensure early sustainable and low cost production of fodder and fuelwood. Studies of the seasonality of fodder outputs; palatability and nutrition studies. Sustainable yields from free standing trees being harvested for production of branch wood and leaves as opposed to plantations being managed for maximization of stem volume.

Intercropping (agroforestry research) into the impact of trees on food crops and into optimal combinations of trees, crops, and animals for different farming systems. Shelterbelt and windbreak design.

Determination of water uptake consumption and stress evaluation. Scope for application of irrigated forestry particularly as this relates to small farmer situations and to larger scale energy plantations for meeting urban fuelwood or other forest product needs.

Research into options for improved organization, transportation, and marketing of small scattered quantities of fuelwood, trees, and timber. Pricing policies, optimal marketing organizations (e.g., farmers marketing cooperatives), role of centralized wood yards, improved harvesting and handling systems for small sized biomass, particularly from energy plantations.

## Appendix X: Nonforestry Research Institutions That Could Contribute to MPTS Networks

Nonforestry Research Institutions that could contribute knowledge and scientific experience to the MPTS networks, *including international institutions located in the country.*

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Arid/Semiarid Zone	Moist/Wet Zone	Mountainous Zone
<b>Australia</b>		
	1. ACIAR—Australian Centre for International Agricultural Research, Canberra.	
<b>Bangladesh</b>		
	1. BARC—Bangladesh Agricultural Research Council	
	2. BARI—Bangladesh Agricultural Research Institute; Joydevpur, Dhaka.	
	3. BAUI—Bangladesh Agricultural University, Mymensingh	
	4. SPARRSO—Space Res. Remote Sensing, Dhaka.	
<b>Canada</b>		
	1. Forestry Energy Agreement, International Energy Agency, University of Toronto.	
	2. Secretariat of programme group on biomass growth and production at Faculty of Forestry, University of Toronto, Canada.	

Arid/Semiarid Zone	Moist/Wet Zone	Mountainous Zone
<b>China</b>		
1. The Agricultural Institute of South China, Guang.		
2. The Tropical Plant Institute Yunnan Province.	1. The Tropical Crop Academy of S. China, Hannan Island.	
<b>India</b>		
1. CAZRI—Central Arid Zone Research Inst., Jodhpur, Rajastan.	1. All India Soil and Land Use Survey, New Delhi.	1. Regional Research Lab., Jammu.
2. Central Grassland Fodder Research Institute, Jhansi.	2. National Botanical Research Institute, Lucknow, UP	2. Agricultural University, Solan.
3. Central Soil and Water Conservation Research and Training Institute, Dehra Dun.	3. Agricultural University, Bangalore.	3. Indo-German Dhauladhar Project, Palampur.
4. Haryana Agriculture University, Hissar, Haryana.	4. ICRISAT Hyderabad.	4. North Eastern Hill University, Shillong.
5. Punjab Agriculture University, Ludhiana, Punjab.	5. Haryana Agriculture University, Hissar, Haryana.	5. G.B. Pant University of Agriculture & Technology, Pantnagar.
6. Indian Institute of Science Bangalore, Karnata.	6. Punjab Agriculture University, Ludhiana, Punjab.	
7. Andhra University, Botany Department, Waltair.	7. Regional Research Laboratory, Jorhat.	
8. Madurai Kam Raj University, Botany Department Madurai, Tamil Nader.	8. Birsa Agricultural University, Ranchi.	
9. Agricultural Research Institute of Rajasthan.	9. Central Soil Salinity Research Institute, Karnal, Haryana.	

Arid/Semiarid Zone	Moist/Wet Zone	Mountainous Zone
<b>Indonesia</b>		
	1. Animal Husbandry Research Institute, Bogor.	
	2. Estate Crops Research Institute, Bogor.	
	3. Agricultural Research Institute, Bogor.	
	4. Soil Research Centre, Bogor.	
	5. Forest Products Research and Development Centre, Bogor.	
	6. National Biological Institute, Bogor.	
	7. BIOTROP, Bogor.	
	8. Indonesia—JICA Cooperation Project in South Sumatra, Jakarta.	
	9. Institute of Ecology, Padjadjaran University, Bandung.	
<b>Malaysia</b>		
	1. Rubber Research Institute, Kuala Lumpur.	
	2. MARDI, Malaysian Agricultural Research and Development Institute, Serdang, Selangor.	
	3. Pertanian University, Faculty of Agriculture, Serdang, Selangor.	

Arid/Semiarid Zone	Moist/Wet Zone	Mountainous Zone
<b>Nepal</b>		
None	None	None
<b>Pakistan</b>		
1. Agricultural University, Faisalabad.		
2. Soil Survey of Pakistan, Multan, Lahore.		
<b>Papua New Guinea</b>		
	1. Wau Ecology Institute, Wau.	
	2. Dept. of Primary Industry.	
	3. University of Papua New Guinea, Port Moresby.	
	4. P.N.G. University of Technology, Lae.	
<b>Philippines</b>		
1. Mariano Marcos State University, Batae, Ilocos Norte.	1. BIOTECH, University of the Philippines, Los Banos, College, Laguna.	1. Mountain State Agricultural College La Trinidad, Benguet.
	2. Technology Resource Centre, Pasong, Tamao, Makati.	
	3. Visayas State College of Agriculture, Baybay, Leyte.	
	4. Isabella State University Echague, Isabella.	
	5. Central Mindanao University Musvan, Bukidnon.	

Arid/Semiarid Zone	Moist/Wet Zone	Mountainous Zone
<b>Taiwan</b>		
	1. Department of Soil Sciences, Chung-Hsing Univ., Taichang.	
	2. Department of Soil Sciences, Nat. Taiwan Univ., Taipei.	
<b>Thailand</b>		
	1. TISTR, Thailand Institute of Science and Technology Research, Bangkok.	
	2. Kasetsart University, Bangkok.	
	3. Chiang Mai University, Chiang Mai.	
	4. Khon Khaen Univ., Khon Khaen.	
	5. King Mongkote Univ., Bangkok	
	6. Institute of Rhizobium, Dept. of Agriculture, Bangkok.	
	7. Asean Institute of Technology, Patumtani.	
	8. Forest Industry Organization, Bangkok.	
	9. Thai Plywood Company, Bangkok.	
	10. Asian/Canada Forest Tree Seed Centre, Moaklek, Saraburi.	



Arid/Semiarid Zone	Moist/Wet Zone	Mountainous Zone
<b>Thailand</b>		
	11. Mae Sa Integrated Watershed Project (UNDP/FAO)	
	12. Asia/Pacific Community Forestry Centre (ADB/FINNIDA, KV).	
	13. Royal Highland Project, Chiang Mai.	
<b>United States</b>		
	1. East-West Center, Environment and Policy Institute, Honolulu.	
	2. College of Tropical Agriculture, University of Hawaii, Manoa Campus.	
	3. NIFTAL, University of Hawaii, Manoa Campus.	
	4. USDA—Forest Service Pacific Island Forestry Institute, Honolulu.	
	5. Benchmark Project, University of Hawaii, Manoa Campus.	

## Appendix XI. Planning Teams for IUFRO Workshop

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<b>Tree Improvement &amp; Propagation</b> <i>Discussion Area 1</i>	<b>Establishment &amp; Tending Techniques</b> <i>Discussion Area 2</i>	<b>Silviculture &amp; Mgmt.</b> <i>Discussion Area 3</i>	<b>Enhancement &amp; Maintenance</b> <i>Discussion Areas 4 &amp; 5</i>
Mathur (Chairman)	Sheikh (Chairman)	Salleh (Chairman)	Ali (Chairman)
Burley (Rapporteur)	Levingston (Rapporteur)	Wood (Rapporteur)	Shepherd (Rapporteur)
Ng	Young	Zsuffa	Hu
Vivekanandan	Manandhar	Shamra	Waring
Tiwari	Gupta	Madamba	Hong
McNamara	Khan	Brister	Anantachote
Sastry	Ghosh	Kermani	Backstrom
Skelton			
Soemarna	Natawiria	Van Tuyll	McFadden
Suree	Esteban	Vergara	Nanayakkara
Huang	Lundgren	Wright	Hadley

## Appendix XII. Participants in IUFRO Workshop

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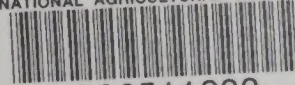
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